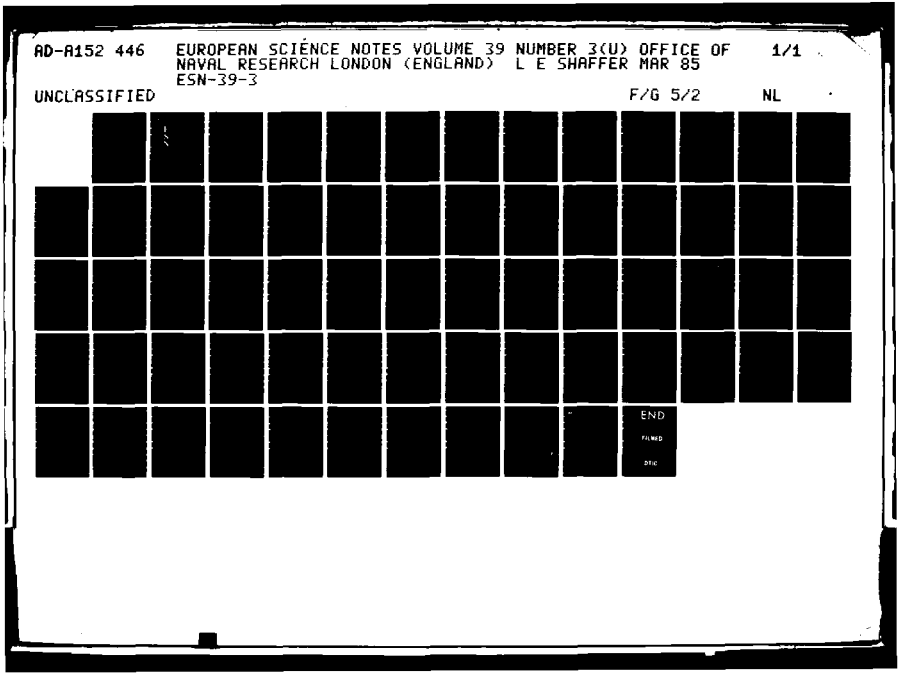
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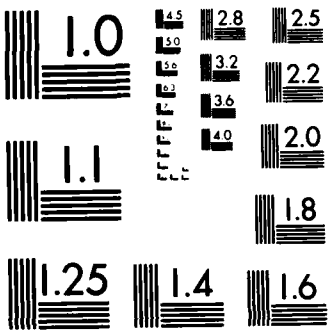

MICROCOPY RESOLUTION TEST CHART

U.S. Office of Naval Research, London

Vol 39 No. 3/March 1985

European Science Notes

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European Science Notes (ESN) is a monthly publication with brief articles on recent developments in European scientific research. The publication is not intended to be part of the scientific literature. The value of ESN articles to Americans is to call attention to current developments in European science and technology and to the institutions and people responsible for these efforts. ESN authors are primarily ONRL staff members. Occasionally articles are prepared by or in cooperation with staff members of the USAF European Office of

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March 1985
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Number 3

Behavioral Sciences

Dutch and Swedish researchers are leading in the study of person-situation interactions in personality theory. The center of "Interactional Psychology" is in research on personality theory, but it is exhibited in and gathers strands from several other basic and applied fields, including physiological, clinical, instructional, developmental, and ecological psychology; industrial and ergonomic psychology; behavior genetics; and also ethology and cultural anthropology.

Biological Sciences

The Laboratory of Electronic Developments for the Armed Forces in The Netherlands has developed a computer program that can predict power flux density around radio-frequency (RF) radiators. A team using the program has surveyed RF radiators in industrial and mechanical environments.

To meet Europe's need for an internationally recognized patent depository for animal cells, the UK has established the National Collection of Animal Cell Cultures. This article describes the NCACC's services.

The Chemical Defense Establishment (CDE) is the UK's center for R&D on defenses against chemicals that may be used in war. This article provides an overview of CDE's research divisions.

Computer Sciences

The National Engineering Laboratory has developed a method for measuring three-dimensional surface forms which relies on a phase-measuring version of projection moire contouring, operating in conjunction with a digital image analyzer.

Material Sciences

Results of materials-science experiments on Spacelab 1 were reported at the Fifth European Symposium on Material Sciences Under Microgravity. The findings have provided fundamental information on scientific mechanisms which should result in the production of new and better materials.

Mathematics

The Workshop on Liapunov Exponents, held at the University of Bremen, concentrated on the use of these exponents in analyzing the stability of stochastic dynamical systems and the behavior of solutions to the Schrodinger equation or wave equation with random potential.

Mechanics

The International Union for Theoretical and Applied Mechanics (IUTAM) held its Second Symposium on Laminar-Turbulent Transition at Novosibirsk, USSR, in July 1984. The meeting may have been isolated geographically but was not isolated from many new concepts on how turbulence is formed. The symposium covered areas such as receptivity, transition, shear-flow calculations, and chaos.

Physics

This is the first article in a series this month dealing with research in Manchester, England. Cooperation between universities, industries, and government has made the city a major center for scientific research.

The University of Manchester, VUMAN Lasers, Inc., and the University of Manchester Institute of Science and Technology are doing significant work with advanced lasers. Interests include laser technology, laser applications, and nonlinear optics.

Space Sciences

Technology

News and Notes

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Behavioral Sciences

PERSON-SITUATION INTERACTION: DUTCH AND SWEDISH RESEARCH

by Richard E. Snow. Dr. Snow is the Liaison Scientist for Psychology in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on leave until September 1985 from Stanford University, where he is Professor Of Education and Psychology.

Although lip service has long been paid to the observation that human behavior is a function of both person and situation, the broad and fundamental implications of a person × situation interaction perspective for psychology have not been widely recognized or pursued. After various fits and starts over the decades, however, there is now a movement called "Interactional Psychology." Its center is in research on personality theory, but it is exhibited in and gathers strands from several other basic and applied fields, including physiological, clinical, instructional, developmental, and ecological psychology; industrial and ergonomic psychology; behavior genetics; and also ethology and cultural anthropology. Still, however, there are relatively few programmatic efforts aimed at the basic issues, and most of these proceed outside the US.

Interactional psychology as a program of new theory and research took shape in the middle 1970s. Endler, in Canada, and Magnusson, in Sweden, joined forces to organize a first international symposium on interactional approaches to the study of personality, held in Stockholm in 1975 (see Magnusson and Endler, 1977). They also brought together for the first time reprints of the many empirical and theoretical fragments scattered through the previous literature (see Endler and Magnusson, 1976). In the US, Cronbach and Snow (1977) formulated a program of interactional research in instructional psychology, called the Aptitude-Treatment Interaction approach, and reviewed the relevant literature from prior educational research. Pervin and Lewis (1978) also brought together chapters reflecting a large sample of US and Canadian interactional psychology. Across a growing spectrum, the work has continued to date.

The present article cannot review this whole spectrum. It concentrates instead on the present status of theory and research in two major European programs: Magnusson's at the University of Stockholm, and Hettema's at Tilburg University, The Netherlands. An overview of the interactionist paradigm, some theoretical detail, and some empirical results from these programs are given.

The Interactionist Paradigm

For over half a century up to the 1970s, there existed in psychology a deep division between so-called "Trait Theorists" and "Situationists." The argument centered on whether observable human behavior was determined primarily by factors internal to the person, or whether the primary factors giving shape to behavior resided in the character of the external, environmental situations in which such behavior took place. Of course, most thoughtful psychologists would have agreed that ultimately both person and situation characteristics would need to be understood. But the question was one of emphasis and research strategy. Psychological science ought to be built first of all on whichever factors provided the soundest foundation; the other factors could then be taken up in that context.

Thus, differential psychologists and personality theorists, for the most part, and also many developmentalists, looked for correlations among human attributes that would help identify and distinguish the internal factors, or traits, that appeared to be enduring and relatively stable predispositions of persons to behave in certain ways. Some theorists acknowledged the importance of situations too, but the style of research usually employed carried the explicit or implicit assumption that identified traits could often be generalized across situations. The situation specificities were to be worked out once the basic person dimensions were established. Experimental psychologists, on the other hand, and especially those working in the mainstream of US behaviorism, manipulated the stimulus situations to influence behavior. Some theorists categorically eliminated internal factors from consideration in scientific psychology altogether, since only external factors were directly observable. Most simply ignored person characteristics in their research; they assumed that external, situation factors could be generalized across persons and that, once the basic behavioral laws were established, individual differences would be just parameter variations in a general model. The contrast between

these two disciplines of experimental and correlational psychology was drawn most sharply by Cronbach (1957, 1975), who outlined a path toward unification through the study of person-situation interactions, but also recognized that the task was extremely complex--and perhaps for the general purpose of establishing scientific "laws" even impossibly so.

The interactional paradigm as it has evolved up to today views human behavior as an aspect of the continuous reciprocal interaction process between situational and personal factors. In studying this process, it distinguishes sharply between the lawfulness of manifest behavior and the lawfulness of perceptions, cognitions, motivations, and emotions; it assumes no one-to-one correspondence between these two levels but rather studies both. It further distinguishes between general and differential effects, that is, between the main effects and the interaction variance observable in a person × situation matrix. It assumes that persons will be best characterized by their unique patterns of stable and changing behavior across situations and that a taxonomy of situations can only be built on descriptions of these person-situation interactions.

Within this framework, the advance of research requires resolution of several critical issues. Among the most important of these are: the measurement system adopted to reflect the functioning of persons relevant to situations; the initial characterization of types of situations to be studied and the resolution of the contrast between situations as perceived and situations as objectively described; and the conceptualization of dynamic functions reflecting change, i.e., adaptation, learning, development, and inconsistency. Another issue is the level of molar versus molecular analysis chosen. Still other issues concern the role played by intentions, goals, and action control (see *ESN* 38-7:349-352 [1984]).

Some of these issues are identified in the schematic organization of Figure 1. There is a person-environment interface extending along a time line wherein the behavioral level is observable. There is an action control level connecting a cognitive-conative-affective level to this behavioral level. There is also a psychological time line (recallable past to foreseeable future) associated with the more abstract-symbolic level. Perception of the situation and of prior behavioral effects can be distinguished from perception of goals and consequences. The stimuli (S) are situational cues processed at upper levels and reflected back to actions or responses (R). But particular stimuli and responses in momentary situations may or may not relate to the characteristics of the prevailing situation type in which an observed moment occurs.

The Hettema Program

Hettema's theory derives from an evolutionary view which emphasizes the development of the human ability to survive outside particular ecological niches. This ability is one of learning to define the prevailing environment, in order to behave adequately in it, and in order to transform it in directions that afford more adequate behavior of which the human is capable, i.e., in biologically useful directions. The activities involved in this definition and transformation process make up Hettema's (1979) central concept of psychological adaptation. For present empirical purposes, however, Hettema concentrates on short-term adaptation.

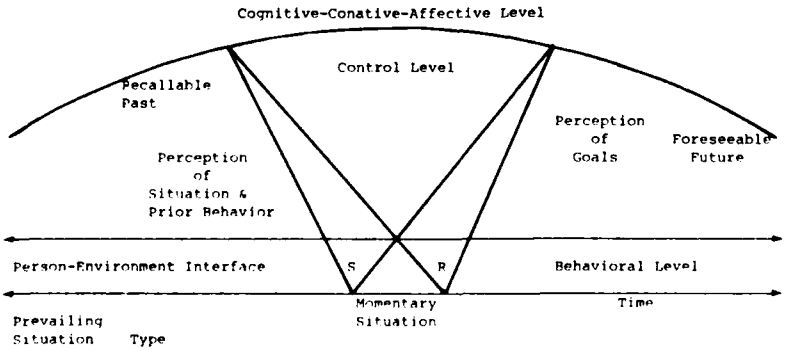

Figure 1. A schematic representation of issues addressed in the interactionist paradigm.

For Hettema, personality is an open system encompassing both human organism and environment. Control and equilibrium are the system goals. Uncertainty in the environment requires continuous human-environment transactions which are defined using situation concepts and transformation rules. Some subset of these concepts and rules is available from culture to each individual at any given moment. Because these concepts and rules are abstractions, however, and because environments are dynamic, individuals fail to analyze and distinguish environments sufficiently, and thus make errors of appraisal. When errors or unanticipated changes disturb the individual-environment equilibrium, loss of control results. The individual applies adaptive mechanisms to restore control. These mechanisms of control mediate between a cognitive-symbolic level and a sensorimotor-operational level of the human system.

A measurement model then is derived as follows. Hettema distinguishes three basic modes and three basic media of measurement. The modes are self-report, psychophysiology, and observation; the media are verbal, pictorial, and natural. In relation to the theory, an analysis of measures in the resulting 3×3 table leads Hettema to choose the diagonal cells, representing verbal self-report, psychophysiological response to motion pictures, and natural observation, as most appropriate for assessment of the cognitive-symbolic, control, and sensorimotor-operational levels, respectively (i.e., the levels that in Figure 1 are called "cognitive-conative-affective," "action control," and "behavioral," respectively).

The measurement of control is particularly critical. Since adaptive control mechanisms come into play due to the disturbance of equilibrium between cognitive-symbolic and sensorimotor-operational levels, and since these are momentary states, the medium must present discrepancies coupled with specific situation concepts dynamically, and in a way capable of being correlated with physiological indices of these control states. Motion picture film in association with the psychophysiological mode of measurement is the obvious choice.

Furthermore, the adaptive, state-transition mechanisms that mediate between cognitive and behavioral levels to fulfill a control function are presumed to be coupled with specific situations idiosyncratically. That is, for each individual person a specific situation is required to elicit any one state-transition mechanism. The action of these mechanisms can be studied in three phases. When discrepancy or disruption first occurs, there are phasic arousal mechanisms that cause specific configurational changes in the input information. Second come mechanisms that direct effort at replacement of initially chosen actions with new, more adaptive actions. Third, tonic activation mechanisms operate to maintain particular goals beyond the immediate situation. These three phases--termed arousal, effort, and activation, for short--are crossed with cognitive-symbolic and sensorimotor-operational levels to posit six distinct control-state mechanisms. These are called reflection, uncoupling, and redirection at the cognitive level, and exploration, substitution, and persistence at the operational level.

The physiological measures are derived from electrocardiogram, skin conductance, and forefinger-temperature records, corrected to remove time-order effects and person main effects, since the aim is to study specific person-situation interactions. In some studies, biochemical measures from blood samples are also used.

To construct prediction models for empirical work on the theory, Hettema (in preparation) identifies the structures of the cognitive-symbolic level as individual strategies which have a competence aspect (i.e., the individual's knowledge of what goes on in a situation) and an intention aspect (i.e., wishes and wants that foster the individual's interests). Strategic predictions concern the contents of behavior. At the control level, the structures are identified as tactics of adjustment in the course of behavior to deal with unexpected disturbances. Tactical predictions concern the forms of behavior, i.e., its order and amount of variation. The prediction models of interest always combine strategic and tactical structures to predict behavior within specifically defined situations.

A range of empirical studies has been carried out within this framework. Some develop and evaluate the person measures needed to test and elaborate the theory. Others concentrate on developing improved ways of defining situations in terms of stimulus cues. Only a fraction of the results are now available in unpublished manuscript form (Hettema and Vingerhoets, no date; Hettema, Vingerhoets, and Van Der Molen, no date). All will be available in a book now being drafted (Hettema, in preparation). Closely related to the program, also, is a dissertation by Van Heck (1981). See also Hettema (1984) and Van Heck (1984).

One line of studies has sought to validate self-report questionnaires about what individuals say they would do in specified situations against what they are observed to do in natural simulated, and role-playing situations. In other words, the relation between the cognitive-symbolic and behavioral levels is explored directly. This is not a simple, straightforward matter because response to questionnaires involves motivational and volitional processes in rather different ways than does response in actual situations. Questionnaires may reflect what persons would like to do, rather than what they would be most likely to do, in particular situations.

The crux of the problem is learning how to specify situations properly in the questionnaires and in the criterion situations, and this brings up the difficult decisions involved in establishing a taxonomy of situations. One must decide whether to seek a broad taxonomy or one limited to a particular domain; whether to adopt language that reflects an abstract, macro-level of generality or a concrete micro-level; whether to emphasize objective situational properties or person-bound qualities, or structural versus content properties; and whether to seek situation descriptions that show high versus low consensus among subjects. Van Heck (1981, 1984) opted for a broad *sampling of* situations and aimed at a level of description about midway between micro- and macro-levels. For example, a macro-level descriptor might be "ideological situations," a micro-level descriptor might be "being at a save-the-whales sit-in"; a middle level would be "being at a demonstration for a cause." This level appears close to what Magnusson (1981) called "situation types" as distinct from "momentary situations."

Most importantly, Van Heck chose to focus on situational concepts of the intersubjective or consensual type, as represented by the language of a culture. From intensive study of the Dutch language, and using certain rules of exclusion, a final list of 248 situation concepts was developed. Then, through intensive interviews, a list of 558 situation cues was developed for specific situation attributes. Correspondence between situation concepts is thus defined as correspondence between these situation cues. Through a series of cluster and factor analyses, it was also possible to identify 10 meaningful classes of situations.

The Hettema program is *now* using this taxonomy in its specifications for questionnaires, filmed situations, and criterion situations. It is also developing a taxonomy of transformational behavior, based on the work of Schank and Abelson (1977) on scripts, plans, and goals in everyday situations. It is hoped that this will expand the situation specification even further.

Of central importance to the project now is the development of measures of the control states that mediate between self-report and behavioral measures. One study, for example, looked for physiological and biochemical response patterns specific to the situations portrayed by particular films. The six experimental films were carefully constructed to elicit different specific emotional state reactions. The aim was to determine if patterns of these variables reflect reliable person × situation interaction effects, as opposed to main effects for person differences or situation differences. Results showed that all nine physiological variables contained substantial person variance--indicating marked individual differences for these measures without regard to situations--but four variables also gave reliable person × situation interactions. These were finger temperature, galvanic skin response level, respiration rate intervals, and ECG T-wave amplitude. Crossed with eight biochemical components (glucose, cortisol, epinephrine, norepinephrine, cholesterol, triglycerides, growth hormone, and testosteron), the resulting patterns could be clustered into distinct state types.

Different films clearly elicited different states, and the presence versus absence of particular states conformed well with theoretical expectations. Thus, it appears that the physiological and biochemical profiles obtained here display construct validity with respect to the control state mechanisms posited.

Another study examined the hypothesis that different cognitive-ability tests would elicit the state transition mechanisms of reflection, uncoupling, and redirection in predictable ways; task differences in this respect would again appear as differing patterns of physiological response, as represented by the four physiological measures identified above. These patterns, for each task, could be compared with the hypothetical pattern expected from theory. Results showed that six of the eight tasks studied did elicit the expected patterns. One task failed, and one task yielded a partially correct pattern. Another analysis examined the further hypothesis that the tasks demand particular state transition mechanisms, so that adequate task performance most likely results for an individual when

the associated physiological response pattern is present, as opposed to some other pattern. Results supported predictions for two of the three state-transition patterns studied--reflection and redirection. The uncoupling state was not confirmed, so further research needs to check the appropriateness of task choice and the correctness of the norm pattern expected for this mechanism. The data in hand suggest that the norm pattern, rather than the task choice, is incorrect.

The Hettema team's progress in developing these unique measures and relating them closely to the theoretical structure is impressive. It remains to be seen, of course, just how well the theory and measurement system stand up in the continuing research.

One important result corresponds to a distinction made by Mischel (1973) between powerful versus weak situations. Hettema's data suggest that situations differ in the degree to which general models versus individual models predict behavior. Powerful situations--i.e., those in which persons perceive aspects of situations in similar ways and have similar expectations with regard to the most probable and most appropriate behavior in them--are those in which general predictions without regard to individual differences are most accurate. In other words, the situation is the most powerful factor determining behavior. However, individual models increase in predictive validity relative to general models as situations become weaker in the sense that persons vary in their perceptions and expectations about behavior in them. The situations being studied by Hettema help define this continuum empirically.

The Magnusson Program

In contrast to Hettema's focus on the control-level functions in short-term adaptation to situations, Magnusson's emphasis is on the cognitive-conative-affective level and the behavioral level in the development of the person over the long-term from childhood to adulthood. Of particular interest is the perception of situations, stress and anxiety reactions to this perception, and social adjustment patterns in development that relate to person-situation interactions in earlier development.

Magnusson also takes an open system view of person and environment but details a variety of subsystems within each. The environment needs to be understood in terms of the distinction between actual physical and social situations and perceived situations as interpreted by persons. The latter is the strongest influence for Magnusson. Environments have characteristics such as complexity, variety, and specificity; these relate to functions that provide context for development and to the concepts of preferred level of stimulation versus developmentally optimal level of stimulation. Environments are also patterned and consistent, allowing prediction control and action control by the person with respect to perceived goals. Change in person-environment interaction is the key to development. The mediating system in persons is regarded as organized contents with associated affective tones and coping strategies. Magnusson emphasizes emotions, values, and self-concept here, because other theories tend to think only of cognitive mediation. He also shows that lawfulness at the behavioral level and lawfulness at the level of cognitive-conative-affective mediation can be quite different matters. Concepts and measures of consistency, for example, must be carefully considered in relation to these two levels. Most importantly, Magnusson insists that theory must aim to understand persons and situations as organized wholes, not just at person and situation variables taken one, or a few, at a time.

Regarding the taxonomy problem, Magnusson argues that situation sampling is dependent on the problem to be studied; there will be no general solution. He thus pursues a psychology of situations, not a taxonomy of situations. For details on all this, see Magnusson (1981, 1983, 1984b, 1984d).

One part of the Magnusson research seeks improved understanding of anxiety-provoking situations. This work can serve as an example of how the program deals with the taxonomy problem and some of the measurement problems. Since the emphasis is on representative sampling of situations as perceived, free-response questionnaires in large samples of the population of concern is one method of choice. Subjects are asked to describe threatening here-and-now situations in their present life; a careful distinction is made between first describing what in a situation makes them afraid and then, second, why they are afraid. This then allows separate categorization of the activating conditions and the expected outcome or consequences. Prior theoretical categories and content analysis of these responses are used by raters to produce a final taxonomy; interrater agreement is typically high. It is then possible to break down the samples of respondents to ask

pixel locations of the CCD camera (by reading the fringe number at each pixel), the three-dimensional form of the object can be computed.

All objects are mounted at an approximately known perpendicular distance from the line joining the perspective centers of the camera and projector. The absolute value of the fringe integer, n, is determined from equation (4) for one point on the surface. Errors of several percent in this initial determination of n have little effect on the accuracy of the subsequent fringe analysis, so precise positioning of the object is unnecessary. The relative fringe integer (the integer value of the fringe count referred to an arbitrary zero fringe on the contour map) and the fringe fraction are added to, or subtracted from, the absolute fringe integer to provide values of $(n + \delta)$ at each pixel and thereby allow evaluation of equations (2), (3), and (4).

Reid et al. (1984) point out that they have demonstrated the feasibility of phase-measuring moire topography with on-line image analysis. The optical geometry can be regarded as a variant of close-range photogrammetry, while the contour analysis uses techniques derived from phase-measuring interferometry.

Figure 2 shows a set of Moire contour maps of a fan blade which were formed with projection grating phases of 0, $2\pi/3$, and $4\pi/3$. The contour interval is 2 mm. The contour patterns were detected by a CCD camera of 244×320 pixels, fed into a 512×512×8 bit framestore and subsequently fed into a microcomputer. Equation (1) was evaluated at each pixel and--using the previously known geometric constants X_{cp}, a_c, and P_p--equations (2), (3), and (4) were used to provide the three-dimensional surface coordinates. The height of the surface was calculated to within 1/180th of the contour interval. Figure 3 shows an isometric view of the object, derived from the contour patterns, while Figure 4 shows a number of cross-sectional profiles derived from the same images. No manual intervention was required between placing the object in front of the system and viewing the graphical output.

Equation (4) is not valid unless certain geometric conditions are met. The camera and projector must be carefully aligned to ensure that the contours accurately represent planar sections through the object. Also, the resolving power of the CCD camera is limited by the number (320×244) of pixels in the detector array. Although the geometric stability of the camera ensures repeatability in measurements of

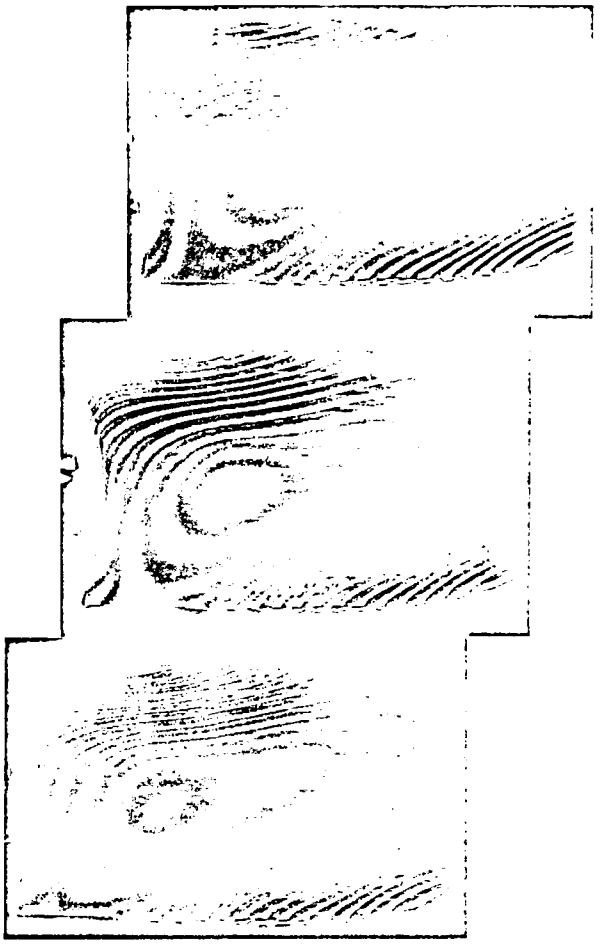

Figure 2. Moire contour maps of a fan blade.

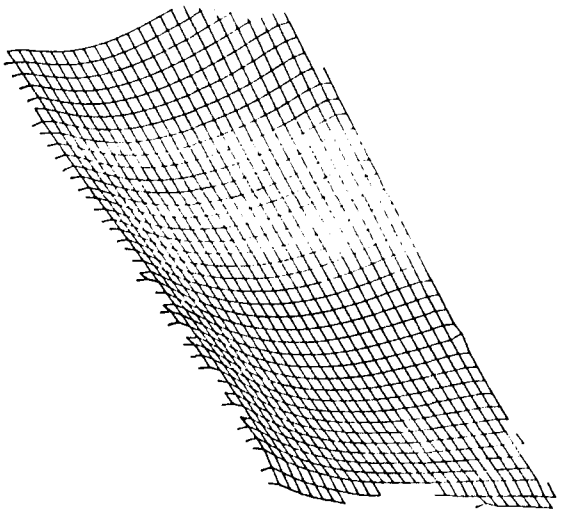

Figure 3. Isometric view of fan blade.

and $I_N(x,y)$ is the intensity level at pixel (x,y) at image number N.

Thus the phase is given by:

$$\Phi(x,y) = \tan^{-1}\beta_1 (x,y)/\alpha_1(x,y). \quad (1)$$

By evaluating equation (1) at each pixel location, the contour pattern is transformed into a phase distribution which does not depend on the optical properties of the object and which unambiguously describes the concavity or convexity of the surface. Since phase values are available at every pixel location, measurements can be made over the entire surface, not just at the fringe centers.

At NEL, equations were derived which describe projection moire topography as a variant of close-range photogrammetry but in which one of the photogrammetric cameras has been replaced by a grating projector. This provides a concise yet readily applicable analysis of the method, and it allows software developed for photogrammetric work to be modified for use in the analysis of projection moire fringe patterns.

Referring to Figure 1, a coordinate system (X_p, Y_p, Z_p) was defined with its origin at the perspective center of the projector and with the Z_p axis lying along the optical axis of the projector. The axes (x_p, y_p) of the projected grating are parallel to (X_p, Y_p), and this grating occupies the plane $Z_p = -a_p$. The lines on the projected grating are parallel to y_p.

Using an analogous arrangement for the camera, equations are derived that explicitly express the three-dimensional coordinates of the surface of the object in terms of the geometry of the projection moire system, the image plane coordinates (x_c, y_c), and the moire fringe number $(n + \delta)$.

$$X = \frac{Z_{xc}}{a_c} \quad (2)$$

$$Y = \frac{Z_{yc}}{a_c} \quad (3)$$

$$Z = \frac{a_c X_{cp}}{P_c (n + \delta)} \quad (4)$$

Assuming that the geometry of the system is known and that the image plane coordinates can be obtained from the

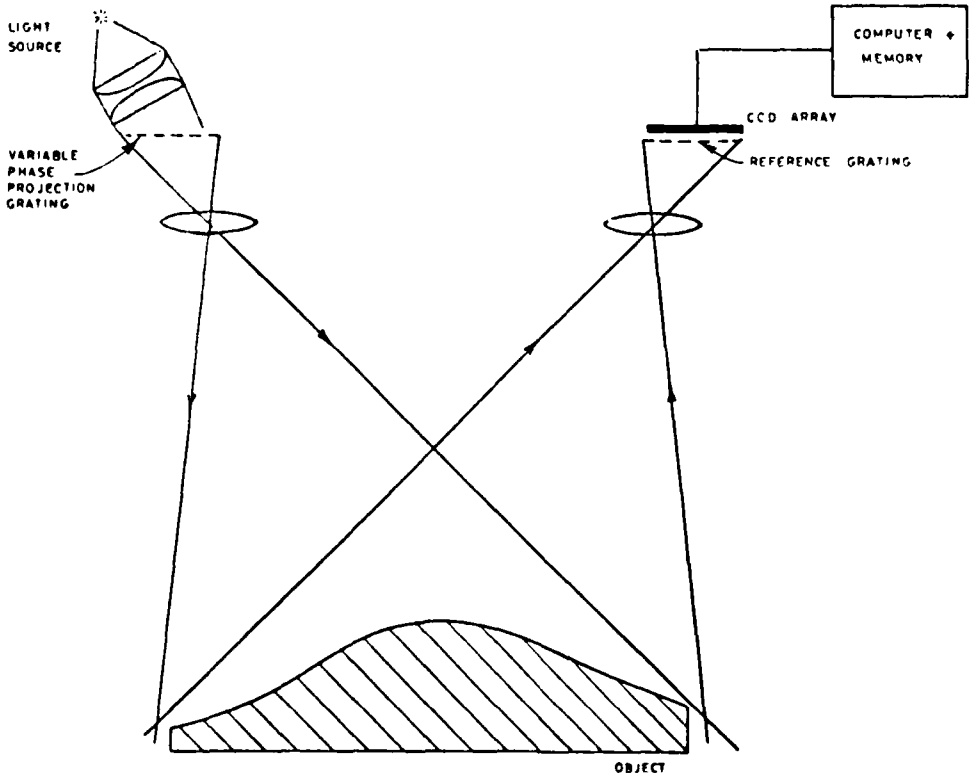

Figure 1. The Auto-MATE system.

electrode. The rate and magnitude of the charge causes an alarm. False alarming is a major problem in the development of battlefield detectors. For example, hydrogen cyanide--existing in low concentrations in exhaust and smoke--is nevertheless lethal when released in sufficiently high concentration. Chemists therefore designed a chemical filter--the silver filter--which prevents all but high concentrations entering the electrochemical detection cell. This material is manufactured in quantity in the pilot plant in the dispersion division. Also, chemists and physicists at the CDE had to refine the nostril on the air inlet to exclude dust particles while allowing the penetration of fine aerosols of toxic agents. Demonstration models of the detector were fabricated with the assistance of the engineering section, and toxicological clearance for the chemical reagents used in the detector was carried out by the medical division.

Conclusion

The CDE is a complex but efficient organization with a multidisciplinary approach to problems concerned with defense against chemical agents and includes a staff of highly competent personnel. A large part of the scientific work is basic research which--in addition to applications research--is relevant to nondefense problems.

12/10/84

Computer Sciences

UK'S NEL USES DIGITAL IMAGE ANALYZER TO MEASURE SURFACES

by J.F. Blackburn. Dr. Blackburn was until September Liaison Scientist for Computer Science in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is now the London representative of the Commerce Department for industrial assessment in computer science and telecommunications.

Various methods have been developed to measure surface form and deformation using optical phenomena: interferometric, holographic, or moire fringe. Also, machines are currently available which link a full-field measuring system to a digital image analyzer. (A full-field measuring system views the surface all at once rather than piecewise to determine the height and deformation contours of the surface.)

The performance of any full-field measuring system depends partially on the quality of the image which is presented to the computer. A major obstacle to the widespread use of this technology is the difficulty in getting high-quality fringe patterns from objects unsuited to this kind of measuring machine.

The National Engineering Laboratory (NEL, East Kilbride, Scotland) has developed a method for measuring three-dimensional surface forms which relies on a phase-measuring version of projection moire contouring, operating in conjunction with a digital image analyzer. Fringe analysis using phase, rather than intensity, measurement reduces the sensitivity of the method to variations in the optical properties of the object and allows fine subdivision of the contour interval. The use of a charge coupled device (CCD) video camera linked to a microcomputer allows direct capture of dimensional information from the object without the intermediate photographic stage used in alternative contouring techniques.

In the Auto-MATE (Automatic Moire Analysis for Topographic Evaluation) system a CCD video camera feeds an image into a framestore (Figure 1). The image, in digital form, is read into the computer memory. The projection grating, of pitch P_p, is moved through a distance $P_{p/k}$ (the phase of the projection grating is moved through $2\pi/k$) and a second image is read into the computer. This process is repeated until the projection grating has moved through (k-1) equal steps, and k images have been stored in the computer memory so that k intensity levels have been stored at each pixel location.

To find the phase $\phi(x,y)$ of the moire fringe pattern at pixel coordinates (x,y), we evaluate the Fourier series coefficients $\alpha_1(x,y)$ and $\beta_1(x,y)$ where,

$$\alpha_1(x,y) = \sum_{N=o}^{k} I_N\ (x,y)\ \cos(2\pi N/k)$$

$$\beta_1(x,y) = \sum_{N=o}^{k} I_N\ (x,y)\ \sin(2\pi N/k),$$

Experimental Ground, which occupies about 90 percent of the 11 square miles of the CDE lands. Many trials are carried out, and solutions have to be found for the practical problems of producing accurate data under difficult conditions. The studies include examinations of the travel and dispersion of clouds, assessments of smoke-screening systems, and examinations of how protective clothing and equipment hinder performance. Most trials involve support from other divisions and sections of the CDE, particularly where chemical or physical analysis, still or motion-picture photography, and special instrumentation are required.

One of the most vital components in all this experimentation is meteorological support. This is provided by a staff from a nearby outstation of the UK's Meteorological Office using both standard and specially designed equipment. A special feature of the range is the Porton Battle Run, which enables troops to exercise in a simulated chemical environment.

Dispersion Division

The objective of this division is to provide training systems for exercises by service personnel so that they can practice using their defensive equipment against disseminated chemical agents. Two training systems developed by this division are being used by the services. One system simulates a chemical attack with liquid droplets, while the other simulates vapor attack. Various methods of disseminating the surrogate agent have to be provided so that any scale of training (from a dozen men up to a full company of 100) can be practiced. There are also facilities for small-scale chemical process work on materials for defense which are unavailable from commercial sources.

The dispersion division also carries out work on smoke research. This includes: (1) developing improved smoke grenades and generators, and (2) screening in the infrared regions to provide countermeasures to the many electro-optic instruments being developed for use on the battlefield.

In association with the medical division, the dispersion division studies the traumatic effect of wounds. They investigate the use of riot-control projectiles, and the effects created by bullets of various calibers are simulated by firing them into gelatine blocks. They also evaluate the combined effects of physical and chemical injury arising from penetration of contaminated protective clothing. Ultra-high-speed photography is one of the tools used to study these effects. In addition, the dispersion division houses an environmental test center where equipment developed for the military is put through rough usage and climatic storage tests to assess its fitness for service use.

Project Teamwork: The Development of NAIAD

Originated by the detection and analysis division, the Nerve Agent Immobilized Enzyme Alarm Detector (NAIAD) is an automatic alarm system which continually monitors the atmosphere on the battlefield and gives soldiers an audible and/or visual alarm signaling the presence of hazardous concentrations of nerve-agent vapor or aerosol. NAIAD simulates the effect that nerve agents have on the body by measuring the inhibition of the hydrolytic activity of the enzyme cholinesterase, the biochemical compound which is poisoned by these agents. Biochemists at CDE invented a method of immobilizing the enzyme by chemically binding it to an inert solid support so that its practical use became economically feasible.

To monitor the activity of the enzyme, the researchers use an organic ester, butyrylcholine, synthesized by the organic chemistry section. This ester is broken down by cholinesterase to form a hydrolysis product, thiocholine. This product is measured electrochemically using a graphite measuring electrode. Physical scientists studied the kinetics and the rates of reaction of the system in order to optimize the concentrations of the various chemicals used during the research stage of the project. When CDE developed the electrode, they had to select a type of graphite that could be used for a long time without undergoing the deterioration in catalytic activity common with solid electrodes. A substance called pyrolytic graphite was adopted because it had a particularly ordered planar structure allowing high conductivity along one axis and negligible conductivity along the other. The electron microscope of the physical protection division was used at this stage to examine the structure of the graphite. This division also developed charcoal cloth, which was adopted for two important applications: (1) to improve the shelf life of the enzyme by absorbing organic vapors from plastics used to make the enzyme holder, and (2) to filter the sampled air when the detector is prepared for use in a previously contaminated environment.

When a nerve agent is used in the battlefield, the enzyme is inhibited, causing a change in the potential of the

Another essential area of the work of the organic chemistry section is the preparation of new drugs for application in the treatment of toxic chemicals. Synthetic studies are also carried out to complement research on the metabolism of chemicals (as part of safety evaluations) in other divisions.

Over the years, the scientists have acquired wide experience in safe techniques for handling highly toxic materials. There are also facilities for the synthesis of compounds on a laboratory scale as well as for the synthesis of radioactive compounds for use in biochemical investigations.

Physical Protection Division

In a chemical attack, the service personnel must be protected not only to preserve their health and life but also to continue their task in war. This division designs and develops equipment to protect personnel from chemicals, no matter what form they take. Respiratory protection is needed against toxic vapors, aerosols, and smoke. In addition, body protection is required against liquid agents.

One of the chief problems of the current protective gear is the physiological stress it can cause when high levels of activity are required of the wearer. The current S6 respirator, for example, is efficient and comfortable but, as with all other respirators, the stress factor is accentuated when hard work is required. A new S10 respirator, currently under development, is expected to reduce the physiological load problem, and modern technology should lead to a less expensive item. In this area of study, the CDE-developed charcoal cloth has been incorporated into a "facelet" recently accepted by the British armed services and can be worn for long periods without physiological strain. It provides a measure of protection against surprise attacks while giving the wearer time to achieve the full protection of his respirator. This is the first major use of charcoal cloth as an accepted military item. The great advantage of this unique material, developed at CDE but now being manufactured under license by two UK companies, is its high rate of absorption, made possible because of its highly microporous structure and the small dimensions of the fibers. This leads to the possibility of respirator canisters having a much lower physiological load than has been practicable and opens up a large number of potential medical and industrial applications, which are being explored.

For the purpose of body protection, the nuclear, biological, and chemicals protective suit is currently used by servicemen. The material of the suit prevents penetration of chemical agents in liquid or vapor form, yet allows water vapor to pass out. The material is sufficiently cheap for the suit to be considered disposable. This protective suit has been so successful that many countries have purchased it.

A particular problem in body protective gear is how to protect casualties who are unable to wear a normal respirator or protective clothing. This problem has been overcome by the devising of a bag of protective material--similar to the suit--into which the casualty can be placed and thereby protected until reaching the field hospital. Development of an improved design is being completed.

There are also situations in which service personnel cannot be expected to carry out their duties while wearing a respirator and protective clothing. For example, a surgeon could not operate on a casualty under such conditions, and areas of collective protection have to be provided. This problem has been tackled by designing filters of various capacities that, with the aid of power-driven blowers, can filter clean air as it is pumped into the protected room. As well as developing the filters themselves, the physical protection division has to design various instruments for testing them.

Behind developments of this type, there is a considerable commitment to research on materials and physiology. This, in turn, is supported by a comprehensive electron microscopy section within this division which also serves the needs of the other divisions of the CDE.

Assessment, Trials, and Range Division

Everything developed for defense use has to be thoroughly tried and tested, and there are extensive grounds for this purpose at the CDE. The assessment section analyzes and interprets intelligence data and provides the British forces with up-to-date assessments of the chemical threat. Served by a computer, teams of scientists and servicemen work together on problems of defense and of protective equipment. They examine how personnel respond to operating in a chemical environment. The results are fed into the computer so that various tactical studies can be undertaken.

The range section of this division is responsible for conducting all field trials carried out on the CDE

respiratory and alimentary tracts--have to be established. For the most part, this has to be determined by using a sufficient range of animal species to make a reliable estimate of how the toxicity of the agent might affect humans. The animal studies are supported by measurements of the toxicity of the agent in isolated tissues and in cell cultures.

To aid in treatment of chemical casualties, the mode of action of an agent in the body is studied, and possible therapeutic drugs are produced to antagonize the effects and to repair the damage caused. To produce an effective drug for the treatment, it is necessary to identify--for both the agent and the drug--how rapidly the compound is absorbed, how long it remains active in the body, and how it is eliminated. It is essential, therefore, to evaluate fully all the effects of the drug. While immediate side effects may be considered acceptable, extensive research is required to ensure the absence of long-term carcinogenic or other effects. Cultures treated with toxins are carefully quantitated in the toxicology section of the biology division.

An isolated perfused lung preparation has also been developed at the CDE as a means of delivering organic aerosols to a mammalian lung. It is used to study the absorption of aerosols with different physico-chemical characteristics. The special apparatus designed by scientists at the CDE enables well-defined aerosols to be delivered to the preparation and the inhaled and assimilated quantities of aerosol are measured using a microcomputer.

For nerve-agent treatment, the military services already have on hand automatic injectors which allow personnel to take immediate action if they feel symptoms of nerve-agent poisoning. Personnel also have tablets which are taken at a prescribed rate when a threat of nerve-agent attack has been established. This combined treatment enables the affected individuals to survive the absorption of many times the lethal dose of a nerve agent. Extensive research is being carried out to refine and improve the treatment, particularly in countering the nerve agent's effects so that service personnel can survive the attack and carry out their military duties.

As with each of the CDE divisions, the biology and medical divisions support the work of the rest of the CDE. For example, toxicological studies associated with new materials for smoke screening are undertaken by these divisions.

Defense Microbiological Division

The major task of this division is to act as a watchtower to monitor advances in microbiological research as long as there is a chance that microbiological forms of attack may be deployed against British forces; this monitoring is an essential defensive measure. There is active research in all the major areas of study, and the programs are being extended as facilities are developed for work with highly pathogenic organisms.

As well as studying the effects of living organisms of various pathogenic intensity, this division is concerned with the chemical products of these organisms--the microbial and fungal toxins--that are toxic to humans. The development of methods of producing mycotoxins such as T2 toxin has provided the basis for the evaluation of such toxins in the biology and medical divisions. There is also an immunology section within the microbiology division where methods are being developed using labeled antibiotics for the rapid identification of microorganisms which might be used in a biological attack. Facilities are also present to enable scientists in the virology section to handle toxic viruses in a safe environment.

In 1942, the first practical demonstration of the likely nature of large-scale biological warfare was made using anthrax spores on Gruinard Island off the northern coast of Scotland. Parts of the island are still contaminated with anthrax. The density and extent of this pollution and the feasibility of decontaminating the island are still being studied.

Organic Chemistry Section

This section has a continuous program of research to establish up-to-date knowledge of the type of chemical agent which could be used against British forces--and which types can be prepared in quantity. Biochemical reaction mechanisms are studied for clues leading to new chemicals that might pose a threat. New biochemical techniques and novel synthetic methods are kept under consideration in case previously inaccessible, toxic, complex chemicals should become easily accessible. As with the microbiological defense division, the organic chemistry section is a monitoring group. An example of this is the section's handling of reports of the use of trichothecane mycotoxins in Southeast Asia. Scientists in this section have prepared mycotoxins as analytical standards and are studying various aspects of their synthesis and chemical reactivity.

research efforts. The main divisions are: (1) detection and analysis; (2) physical protection; (3) biology; (4) medicine; (5) defense microbiology; (6) dispersion; and (7) assessment, trials, and range. The organic chemistry section is an important subdivision that serves all these divisions with a specific research program. Furthermore, staff members in the following areas support the research divisions: (1) engineering, (2) instruments, (3) photography, (4) technical information, (5) animal breeding, and (6) administration. The rest of this article illustrates how the various scientific and technical teams are used.

Detection and Analysis Division

The work of this division includes: (1) determining the nature of an initial chemical attack; (2) ascertaining how the attack is made; (3) determining the method of detection; and (4) analyzing the type of agent used. For the serviceman under a threat of chemical attack, the first requirement is to be able to detect such an attack. In many cases, a chemical attack can be made covertly, and its first sign may be the reactions of those affected by this particular type of environmental pollution. The very high toxicity of chemicals such as nerve agents and the spread of action of these chemicals mean that highly sensitive monitoring equipment is needed. The equipment has to be extremely rapid in initial response and specific to toxic agents. It must be capable of identifying a specific toxic agent or the class of toxic agent in a completely reliable manner without giving false alarms created by smoke, vehicle exhaust, or other battlefield contaminants. Chemical agents may also occur in liquid form as droplets, and detectors are needed for detecting this type of attack and for differentiating the agents from rain. In addition, methods are required for ensuring that water supplies are free from chemical contamination.

Because of the complexity of the problems of detecting not only chemical agents but also the products they form after degradation has occurred, CDE has developed sophisticated detection equipment supported by a comprehensive analytical service using gas/liquid chromatography and infrared and mass spectroscopy. Nuclear magnetic resonance and atomic absorption spectroscopy are also involved. The analytical service has also built up a library of spectroscopic data.

Another important goal of this division's work is to control the contamination of equipment, personnel, vehicles, and terrain. The division studies typical reactions between the chemical agents and possible decontaminants as well as establishing the possible damaging effects of the decontaminants themselves on equipment. The division also provides a comprehensive analytical service to the other divisions of CDE. For example, assistance might be given to the biology division on the identification of the structures of a metabolic product of a drug, or analysts may be sent out on a field trial to sample and analyze the constituents of a smoke screen used in experimentation.

The comprehensive nature of the detection and analysis division and the facilities it makes available are highly relevant to the general problems of environmental pollution. A major contribution in this respect has been the development of the CDE Passive Diffusion Samples. This is a badge containing a piece of charcoal cloth (a material developed at the CDE that has many applications in environmental pollution control) covered by a membrane to control the diffusion rate. The badge is worn for a period (usually 8 hours) and sent to the laboratory for analysis. The result provides an accurate record of the average concentration of chemical vapor to which the wearer has been exposed. It is of particular value in industries where operators may work in an atmosphere containing solvent vapors. Another application is in hospital operating rooms, where the staff is continuously exposed to anesthetic vapors.

Another simple, effective device which can be used as a test for pollution has been developed by the detection and analysis division. It consists of a narrow glass tube containing a bed of polymeric absorbent. Air is drawn through the tube at a known rate, and any contamination is retained on the bed, which after elution by a suitable solvent can be determined by a gas chromatographic technique. It has been shown that samples obtained with the glass/absorbent device can be retained for up to 2 to 3 weeks without any loss due to degradation as shown by gas chromatographic analyses.

Biology and Medical Divisions

No matter how effective the equipment used for protection may be, there are bound to be personnel affected by chemical agents. The work of the biology and medical division is to find out how agents attack the body and to provide methods of treatment, including both prophylaxis and therapy. First, the toxicities of the agent through the skin and eyes--as well as through the

future supplies rather than to act as a distribution agency as long as alternative sources remain available.

Distribution and Cataloguing Services. Cells obtained from individual depositors, or under contractual agreement, can be distributed from this central facility, thus relieving scientists of the burden of using their time and resources to maintain seed stocks and dispatch cells. The NCACC will accumulate data obtained within its own laboratories, and from users, on all lines held. The NCACC could also act on behalf of users as a central liaison authority with other international cell banks.

Other Services. The NCACC offers the following: (1) the freeze-preservation of cells, either by routine techniques or by determining the optimal conditions for maximum viability, together with the retention of unique characteristics or functions; (2) an identification service, including karyotype analysis and isoenzyme analysis; (3) sterility testing for mycoplasmas, bacteria, fungi, and selected viruses; (4) functional testing for virus susceptibility, product expression, antibody studies, etc.

Research. Research topics in the general area of genome preservation, stability, product expression and identification, and quality control will be pursued. This will provide an opportunity for funding by research councils and for contract research.

The NCACC is housed in a purpose-built suite of laboratories adjacent to the main building of the PHLS Center for Applied Microbiology and Research. There are specialist laboratories for tissue culture, microbiology, and biochemistry. Doyle, the curator, is responsible to the director of the Vaccine Research and Production Laboratory for the day-to-day management of the NCACC. An advisory committee representing users and funding bodies will provide an additional safeguard of the commercial integrity and independence of the culture collection as well as advising on scientific policy. There will be close liaison with other national and international culture collections.

A nondifferential charging system has been introduced and will be levied on all services, except for the deposit of a cell line which has no restrictions on its distribution; such deposits will be free of charge.

The NCACC facilities are excellent and contain the latest cell-handling equipment as well as an excellent support staff. All information on the animal cell cultures is computerized for easy access. This facility serves a very important function and has been needed for some time. The British government is to be commended for support in building and organizing facilities which will be of great help to European scientists.

12/11/84

UK LAB PROVIDES DEFENSES AGAINST CHEMICAL AND BIOLOGICAL WARFARE

by Claire E. Zomzely-Neurath and Thomas C. Rozzell.

The Chemical Defence Establishment (CDE) is the UK's center for research and development on defense against chemicals that may be used in war. Added to this important role is the responsibility for biological defense research, since the work of the former Microbiological Research Establishment has been transferred to CDE.

The prime aim of the CDE is to develop protective equipment and clothing for British service members who may be subjected to the hazards of chemicals or biological materials deliberately unleashed to pollute the environment in war. While CDE's work is entirely for defense purposes, the research and development also helps scientists increase their knowledge and experience for many other purposes. An important by-product of 60 years' work in this field, conducted intensively on a laboratory scale, is the knowledge of methods of countering any accidental environmental pollution that may occur. There are also numerous types of protective equipment, developed initially for servicemen at war, that have equally applicable peacetime uses in potentially hazardous environments such as mines and hospitals.

These achievements were made possible by a high standard of research by scientists specializing in the various fields of physics, chemistry, and biology. Scientists conduct research at CDE--which is at Porton Down, 6 miles northeast of Salisbury--and also make use of the extensive adjoining lands for trials and assessments.

Because of the very diverse nature of the studies carried out at CDE, there are several divisions, each responsible for a specific area of the research workload and each supporting the shared interest of the others. Teamwork of this sort is essential for maximum efficiency and effectiveness of the

was carried out by a military laboratory for a civilian agency. It is also the first time, to my knowledge, that an attempt has been made to develop a computer program that can predict PFD around an RF radiator used in industrial and medical environments. Surveys have been made on board ships and around commercial broadcasting antennas by various groups in the US and other countries. An approach like that used by the TNO group might have application to the problem of predicting levels of exposure to US Navy personnel on the decks of ships, particularly in the multifrequency environment, where it is often difficult to integrate the PFD due to transmitters operating at several different frequencies.

12/5/84

UK ESTABLISHES NATIONAL COLLECTION OF ANIMAL CELL CULTURES

by Claire F. Zomzely-Neurath and Thomas C. Rozzell. Dr. Zomzely-Neurath is the Liaison Scientist for Biochemistry, Neurosciences, and Molecular Biology in Europe and the Middle East for the Office of Naval Research's London Branch Office. She is on leave until July 1986 from her position as Director of Research, the Queen's Medical Center, Honolulu, Hawaii, and Professor of Biochemistry, University of Hawaii School of Medicine. Dr. Rozzell is the Liaison Scientist for Biological Sciences in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on reassignment until August 1985 from the Office of Naval Research, Arlington, Virginia, where he is Program Manager for Cellular Biosystems.

To meet Europe's need for an internationally recognized patent depository for animal cells, the UK has established the National Collection of Animal Cell Cultures (NCACC). Dr. Alan Doyle is the Head or Curator of the NCACC. (A preliminary report about this facility was issued as ONR, London, Science Newsbrief 2-4-84, last July.)

The first such facility for animal cell cultures in Europe, the NCACC is in Porton Down, Salisbury, Wiltshire. It was opened in July 1984 under the auspices of the Public Health Laboratory Service (PHLS), as part of the Department of Trade and Industry's program to support biotechnology in the UK. Previously, there had been a gap in Europe in the worldwide network of national culture collections--a gap which had become more apparent as a result of increasing emphasis placed on the use of animal cells in biotechnology.

In the past, scientists in the UK and on the Continent had to obtain animal cell cultures from the American Type Culture Collection in the US. This was expensive primarily because of the high cost of the specialized shipment required for transporting animal cell cultures.

The NCACC is envisaged as a service facility to commercial and research organizations throughout Europe, and therefore its development will depend upon the requirements of its users. Some of the services currently offered by the NCACC are discussed below.

Patent Cell Depository. The NCACC is registered as an International Depository Authority under the terms and conditions of the Budapest Treaty, as administered by the World Intellectual Property Organization. In this capacity, it serves as an archival holder of certified cell lines in support of patent applications.

Safe Deposit Facilities. Individual scientists and commercial organizations who wish to safeguard valuable cell stocks can deposit ampoules for a rental fee. Commercial organizations that use or supply cell cultures can use the facility to have their seed stocks expanded under certified conditions, in addition to using the safe deposit facilities.

Specialist Collections. Various collectors within a particular field, research councils, and some international organizations may require a central bank of specialized cell types for standardization purposes--e.g., biopsy cell lines with genetic or immunological markers, human homozygous typing cells, or cell lines derived from families for disease marker studies. Such lines could be available for open distribution or only within a recognized group of depositors.

National Collection. All scientists will be actively encouraged to deposit well-studied cell lines for accession to a National Cell Culture Collection in which cells, after characterization, will be available to all applicants.

National Reserve Collection. The policy is to maintain examples of all the internationally recognized and well-characterized cell lines as a guaranteed safeguard against possible imposition of import/export restrictions in the future. The aim is solely to guarantee

existed in the environment around several types of equipment. These measurements were done in industries using RF energy for such tasks as sealing plastics, and in medical situations for which diathermy is used. This was the beginning of data collection to verify the computer model. Three different types of sealing machines were measured at two different plants. Field intensities were measured in the vicinity of the operator positioned in the normal operating position.

Figure 1 shows the results obtained for all of the sealing machines measured. It is interesting to note that approximately 14 percent of all values are higher than 10 mW/cm^2, and roughly 56 percent are higher than 1 mW/cm^2. Some types of machines are worse than others, with the turntable machine giving, for example, 78 percent of the measurements in its vicinity above 1 mW/cm^2. (All vaules were corrected for duty cycle, i.e., the sum of the time period when the power is "on" and "off.") When the extreme exposure levels were examined, it was found that this was about the same for all three types of machines (around 30 mW/cm^2), but the part of the body exposed at the maximum level was different. In the case of the "sewing" type, the knees received the maximum, while it was the head for the "shuttle tray" machines and the waist for the "turntable" type (Figure 2).

Although the sample size was too small to draw conclusions concerning all types of sealers, the project team did draw some general conclusions:

- The exposure levels are fairly high.
- Peak levels are two to 10 times higher depending on the duty cycle; the maximum peak level found was 300 mW/cm^2.
- Levels can be reduced by shielding; a shielding effectiveness of more than 20 dB was measured.

Measurements of medical diathermy units were carried out in two parts. First, measurements were made of some units in the laboratory using a probe mounted on a mechanical positioner that could be moved in all three directions in front of the diathermy unit. A series of scans was thus made in the X-Z plane at different distances Y from the applicator. From these scans it was possible to get an impression of the spatial distribution of the PFD around the diathermy applicator. This is, of course, without benefit of a patient in place.

To obtain a reasonable picture of the RF levels to which operators of diathermy machines might be exposed, the team went to four different training centers where physiotherapists were trained in the use of the devices. During treatment sessions the team measured the PFD at a number of positions close to the units and close to the patients. Normally, the power setting used was one that produced a slight sensation of heat in the patient.

Although the PFD levels were at the position of the treated body parts, it was found that all values in positions where the operator might be--or at untreated parts of the patient's body--were generally less than 10 mW/cm^2.

Concluding Remarks

This type of survey and computer modeling project is unique in that it

Table 1

List of Parameters

I General	II Antenna	III Transmitter
1 name	11 type	32 power
2 application	12 illumination	33 freq band
3 info source	13 dimensions	34 p.r.f
4 location	14 beamwidth	35 duty cycle
10	31	39

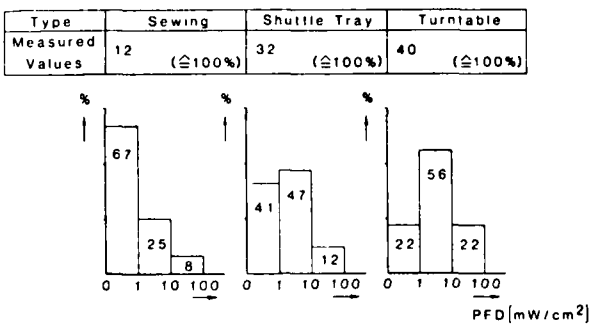

Figure 1. Exposure results for sealing machines.

Sealer type	No units	Exposure level (mW/cm^2) min	Exposure level (mW/cm^2) max	Part of body max. exposed
Sewing	3	<0.2	26.4	Knees
Shuttle Tray	5	0.2	30	Head
Turn-table	5	0.2	29.7	Waist

Figure 2. Exposure levels by type of machine.

Biological Sciences

DUTCH MILITARY LAB SURVEYS RF-GENERATING EQUIPMENT

by Thomas C. Rozzell. Dr. Rozzell is the Liaison Scientist for Biological Sciences in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on reassignment until August 1985 from the Office of Naval Research, Arlington, Virginia, where he is Program Manager for Cellular Biosystems.

The Laboratory of Electronic Developments for the Armed Forces in The Netherlands recently conducted a survey of radio-frequency (RF) generating equipment in the country. The survey was commissioned by the Ministry of Health and Environmental Hygiene and included most of the civil RF sources in the frequency band from 0.5 MHz to 18 GHz. In addition to doing an inventory of the range of transmitters, the project had as its objective the development of a computer model that will be capable of predicting the RF environment from a knowledge of certain of the parameters of the transmitter.

In a recent visit to the laboratory, an institute of The Netherlands Organization for Applied Scientific Research (TNO), I learned that this project was carried out by a military institute for a civilian agency because no agency within the civilian part of the government has the expertise needed for such a survey. It was interesting that no consideration was given to military sources of RF energy. There is no legal standard in The Netherlands for human exposure to electromagnetic energy, although the American National Standards Institute standard is highly regarded and generally followed by anyone wishing to use some sort of guideline. The military, however, seems a bit isolated from such considerations, and apparently no guidelines are actually followed by military operators--except for keeping exposures as low as possible. This probably works quite well given the size and complexity of the military force in The Netherlands.

Approach to Study

The project team did not set out to survey every installation that had RF-generating equipment as this would have been impossible in the time allotted. Instead, a representative sampling was made and, using literature sources about industries, the team was able to extrapolate data for the whole of The Netherlands. Several classes of generators were evaluated in the laboratory as well as being measured on location and in actual use. Three types of medical diathermy equipment were studied: shortwave (27.12 MHz), UHF (433.92 MHz), and microwave (2450 MHz). RF heaters and sealers--such as those used for sealing plastic materials, gluing wood, and drying potato chips--were evaluated at in-plant locations.

The computer program developed under the project was designed so that it will roughly predict the RF-environment around different types of emitters using the transmitter parameters. The first task was to decide which parameters should be sought. The ones chosen are listed in Table 1 (page 80). These parameters were considered easy to obtain from operators of the equipment and from public records. However, it was realized that in some cases, these parameters might not be very accurate. It was often difficult to obtain the needed information from public documents or from owners and operators of transmitting devices. In some cases it was necessary to seek the information from the manufacturer or to estimate it. This task was more labor intensive than was originally thought, and to date, parameters have been fully obtained for only 150 sources of RF energy.

Different approaches are used to calculate the power flux density (PFD), depending on the completeness of the input data. For instance, if the illumination of an aperture antenna is unknown, the program uses other parameters to estimate the illumination (such as the dimensions of the aperture and the beamwidth). In addition, the program can manipulate data, such as updating the data bank and ranking the transmitters. Finally, it can plot different graphical presentations such as:

- PFD as a function of distance of one transmitter.
- Maximum PFD as a function of frequency of a selected subset of transmitters.
- Geographical view of transmitter locations.
- Some form of statistical information, such as the number of transmitters and the distances at which their PFDs exceed a definite value.

Study Results

A crucial part of the survey was the measurement of actual fields that

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level could each be related to adrenalin excretion at age 13, and criminality at adulthood. The results suggested that it is motor activity at age 13 not aggressiveness that is most predictive of criminality. The data on adrenalin excretion correspond; a pattern of high motor activity and low adrenalin excretion, not aggressiveness *per se*, appears to be associated with later criminality.

Summary

The Magnusson and Hettema programs are quite different, and the differences are magnified in Table 1, which attempts to contrast them on key points. Yet they are also similar to one another, and different from American efforts, in several ways. Both emphasize the systematic analyses of the dynamic interaction of person and environment, at several levels of measurement. Both examine person change in relation to environmental conditions and environmental change in relation to person action. And both remind us that situational sampling is crucial. US cognitive psychology attends to none of these points, even though US personality and social psychology does, increasingly.

Table 1

A Contrast of the Hettema and Magnusson Programs

	Hettema	Magnusson
Time span within person	Short-term adaptation Contemporaneous	Long-term adaptation Developmental
Level focus	Action control level	Cognitive-conative-affective level Behavioral level
Person focus	Person variables	Persons as wholes
Situation focus	Situations as objectively or consensually defined	Situations as perceived
Concern for representativeness of person sampling	Substantial	Substantial
Concern for representativeness of situation sampling	Moderate	Substantial
Measurement emphasis	Physiological and biochemical related to control	Cognitive-conative-affective related to behavioral and biochemical
Macro-micro distinction	Micro	Macro
Taxonomy	General	Local to problem studied
Concern for goals, intentions, etc.	Moderate	Substantial

questions such as: Do 12-year-old boys experience the same situations as threatening as do 18-year-old boys? Do males and females differ in this respect at a given age? Are there urban-rural or other cross-cultural differences? Such descriptions and their frequency of occurrence provide a guide to judging the representativeness of both person sampling and situation sampling for further research and permit the choice of appropriate situations for the study of fear and anxiety in particular populations. A further step allows the construction of an intensity scale for each category and factor analysis to reach outcome dimensions of anxiety-provoking situations.

Further work on the frequency-intensity contrast has turned up important sex differences, for example. Among male teenagers, intensity and frequency of anxiety-provoking situations were negatively correlated with each other, but frequency was not correlated with cognitive preoccupation and worry. For female teenagers, intensity and frequency were positively correlated with one another, and frequency was also positively correlated with cognitive preoccupation and worry. The suggestion is that situation perception operates quite differently, and with different effects, among males and females (Törestad and Magnussor, 1982).

This has important implications for other research seeking, for example, relations between physiological or biochemical reactions and stress or anxiety reactions. Magnusson (1984c) gives several examples:

1. It has typically been found that men exhibit stronger adrenalin reactions to stress than do women. But the situations studied usually demand achievement. If the situation studied threatened separation from social contacts, a situation found to be more stressful for females than males, then females might show more adrenalin reaction. Some current data suggest that this is the case.

2. Some situations are experienced as anxiety-provoking by some individuals but as anger-provoking by others. To test the old hypothesis that adrenaline accompanies anxiety reaction while noradrenaline accompanies aggressive reaction, one has to take situation perception into account. Previous studies have not done this.

3. Stability in rank order of individuals in adrenaline and noradrenaline excretion can be investigated across different types of situations. When this was done to compare laboratory situations with everyday life situations, it was found that rank order was stable across different laboratory situations but variable across different everyday situations. This suggests that the laboratory situation as such, not the specific manipulations introduced by the experimenter, produced the main reaction.

The message for Magnusson here is threefold: the sampling of persons and situations must ensure representativeness with respect to the aim of generalization; persons and situations must be studied as wholes, and the perception of the situation by the person is crucial; what is needed are local theories of categories of persons in categories of situations with respect to particular psychological programs.

This theme is then carried into longitudinal developmental research in a project that has been following a large sample of Swedish students since the mid-1960s. The primary aim is to study the development of maladjustment (Bergman and Magnusson, 1983). Two examples of results from this work can be noted briefly here.

One concerns the relation of differences in physical maturation and alcohol habits in adolescence and adulthood. At age 14, early-maturing females were found to have higher frequencies of drunkenness than later-maturing females. As maturation continued, this difference diminished until, in adulthood, there was no correlation between age of menarche and drinking habits. The effect is interpreted as a function of the situational conditions in which early- and late-maturing females find themselves (Magnusson and Stattin, 1982).

Another study (Magnusson, 1984a) collected all the criminal, alcohol problem, and psychiatric records available in Sweden on males in the longitudinal sample (who were by then age 28) and related these to measures of aggressiveness, motor activity, and urine adrenaline excreted under active and passive conditions, collected when the subjects were at age 10 to 13. The aim was to test the often observed "fact" that aggressiveness at school age is highly predictive of young adult criminality, and the related observation that adrenalin excretion is lower in criminals.

The prediction held also in this study; adrenaline excretion at age 13 was negatively correlated with adult criminality. However, it was also recognized that teacher ratings of aggressiveness could often be confounded with those for motor activity; by separating the two, aggressiveness and activity

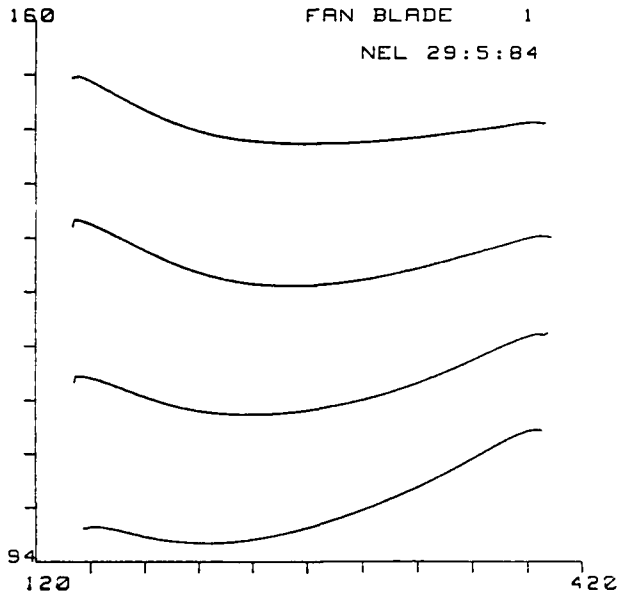

Figure 4. Cross-sectional profiles of fan blade.

the lateral coordinates of surface points, the positions of the edges of the object cannot be accurately determined. Furthermore, since the camera cannot resolve the closely packed contours which appear on high surface gradients, the system is limited to the measurement of objects with slopes of a few tens of degrees or less. The resolution of closely packed contours can be improved by increasing the contour interval so that fewer contours are present in the field of view.

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Material Sciences

MATERIALS-SCIENCE RESEARCH UNDER MICROGRAVITY CONDITIONS

by Kenneth D. Challenger. Dr. Challenger is the Liaison Scientist for Materials Science in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on leave until May 1986 from the Naval Postgraduate School, where he is Associate Professor of Materials Science.

The European Space Agency (ESA) and the German Aerospace Research Establishment (DFVLR) in cooperation with the European Low-Gravity Research Association (ELGRA) sponsored the Fifth European Symposium on Material Sciences Under Micro-Gravity from 5 through 11 November 1984.

The previous symposium on this topic was held in April 1983. However, with the flight of the Spacelab 1 experiments in November 1983, more new information was presented at the fifth conference than at any of the preceding four. The proceedings were to be available by February 1985. Interested parties should write to: Mr. T.D. Guyene, ESA Scientific and Technical Publications Branch, ESTEC, Noordwijk, The Netherlands. The symposium was organized by Professor B. Feuerbacher, Director of Space Programs for DFVLR. (For information about ELGRA, see *ESN* 38-9:505-508 [1984].)

Background

Materials are studied under microgravity conditions for two reasons. First, for science--to learn more about the fundamental mechanisms which control the properties of materials on Earth; the microgravity environment allows the study of certain parameters which cannot be studied in the presence of gravitational forces (e.g., the mechanism of thermal diffusion in liquids). The Spacelab experiments have demonstrated that research under microgravity conditions will lead to improved materials and methods for processing materials on Earth. This, at least for the next 10 to 20 years, is likely to be the most valuable aspect of microgravity materials research.

Second, materials processed in space sometimes have desirable properties which cannot be achieved by processing under gravity. It is difficult to imagine at present many examples justifying the expense of processing in space; however, there have already been many scientific surprises and no doubt more will occur. Therefore, it is difficult to eliminate the possibility of commercial materials processing in space. One example of a pioneering space-processing venture is a collaborative program between the US National Aeronautics and Space Administration

(NASA) and the Microgravity Research Corporation; they will grow GaAs crystals in space. These partners believe that there is an existing market for this material. At the symposium, Professor A. Gatos (Massachusetts Institute of Technology [MIT]) explained the process which he and his coworkers at MIT have developed for the growth of GaAs crystals. These crystals, grown on Earth by an electroepitaxial growth method, have demonstrated an electronic mobility which approaches that theoretically obtainable for GaAs. Thus they are nearly defect-free crystals. The problem is that with this method only small crystals can be grown. The volume of solution required to grow a large crystal becomes so great that convection currents in the liquid are induced by gravity and produce crystalline defects, reducing the electronic mobility of the crystal. In space, convection currents are eliminated; therefore it should be possible to produce larger crystals with the same high electronic mobility obtainable in the smaller crystals. Although several commercial projects in the field of biomedicine in space have started, this appears to be the only materials science project with commercial possibilities reviewed at this symposium. These GaAs crystals are not expected ever to replace silicon in semiconducting devices but to extend the use of semiconductors. Although the space-processed GaAs crystals are expected to cost about $100,000 per kilogram, Gatos believes that they will have immediate applications as substrates for lasers and as high-reliability fast switches.

Spacelab 1 Experiments

For this discussion I have divided the Spacelab experiments into three types: (1) development of techniques for the direct application of materials processing in space; (2) fundamental understanding of mechanisms in materials; and (3) development of new or better materials. The Spacelab 1 experiments included the study of the properties of liquids (diffusion and convection); crystallization (nucleation mechanisms); surface energy measurements of liquid surfaces and of liquid/solid interfaces (Marangoni induced flow, capillary forces, and interface effects on the diffusion in liquids); dampening properties of liquids; and the growth mechanisms of organic crystals (proteins) from solution.

The results of the Spacelab 1 experiments on materials have provided fundamental information on scientific mechanisms which should result in the production of new and better materials on Earth. The general attitude of the participants of this symposium regarding materials processing in space during this century is not optimistic; however, the scientific information gained from the Spacelab experiments appears to have justified their expense.

Type I Experiments. The production of metal matrix composites in space may improve the adhesion between the metal and the fibers or particles of the composite. In addition, production in space eliminates many of the problems that are caused by gravity and that are inherent in liquid phase production of these composites on Earth--namely particle movement, agglomeration, and sedimentation. L. Froyen and A. Deruyttere (Katholieke Universiteit Leuven, Heverlee, Belgium) had modest success in improving the properties of Al-Al_2O_3 and Al-SiC particle composites in space. Fully dense Al powder with Al_2O_3 or SiC particles was melted in the Spacelab's isothermal furnace facility. These samples have a more homogeneous distribution of particles than those similarly processed on Earth. This distribution results in improved abrasive wear resistance and a 20-percent increase macro-hardness.

Attempts to produce unidirectionally solidified cast iron in space by W.H.M. Alsem, T. Luyendijk, and H. Nieswaag (Technische Hogeschool Delft, The Netherlands) were unsuccessful. Convection currents in the liquid, believed to be due to Marangoni flow, resulted in a graphite-flake distribution similar to that observed on Earth.

Several experiments tested the concept of skin technology in space processing. The main idea is that a finished shape formed on Earth is coated with a thin skin of Al_2O_3; the component is then remelted in space. The refractory skin has two purposes: first, to maintain the finished shape which was formed on Earth, and second, to stop Marangoni convection by eliminating the liquid/gas interface when the material is remelted. An experiment where a gas turbine blade was remelted in space by this method was performed by H. Springer (MAN Neue Technologie, München, West Germany). The more important findings of this experiment are that the skin must be about 50- to 100-μm thick in order to be strong enough to counteract capillary forces, the liquid should wet the skin, and a special nonwetting reservoir must be used to accommodate the volume changes which occur upon melting and solidification.

E. Siegfried (Fachgrappe Fügetechnick der Bundesanstalt für Materialprüfung, Berlin) and K. Frieler and R. Stickler (Institut für Physikalische Chemie der Universtät Wien, Wien, Austria) discussed an experiment on vacuum brazing. The objective of this experiment was to demonstrate that capillary forces under microgravity conditions would result in a better distribution of the brazing material than occurs on Earth. The construction and repair of components in space will require joining of materials by this method. This experiment demonstrated the feasibility of brazing in space.

Type II Experiments. Many of the Spacelab 1 experiments fall into this category; in my opinion, the most significant results have been obtained from these type II experiments.

In space, gravity becomes an experimental parameter which can be controlled. (At least this is true in theory; but in Spacelab 1, gravity was reduced to about 10^{-5}g and not controlled very well. Acceleration of the spacecraft due to movements of the crew, orbit-adjusting maneuvers, atmospheric drag, and other factors resulted in randomly fluctuating forces on the order of $\pm 10^{-4}$g with occasional peaks as high as 10^{-3}g.) The reduction of gravity allows the study of some mechanisms which cannot be studied on Earth. This is especially true for heated liquids, where gravity induces thermal convection, and for the crystallization of liquids, where nucleation and growth mechanisms are often dominated by gravitational effects.

Since there were many experiments in this category, I will discuss only those which produced new information of a fundamental nature. Perhaps the most important result is the verification that convection in heated liquids with a free surface will still occur in space. The convection currents are not caused by buoyancy forces as in thermal convection, but are due to variations in the surface tension of a free liquid surface caused by temperature variations.

L. Napolitano and coworkers (University of Naples, Italy) have performed several experiments on this topic prior to and in Spacelab 1; the results have provided a basis for the development of quantitative mathematical models of Marangoni flow. All of these experiments in Spacelab 1 used the fluid physics module with silicon oil as the working fluid, primarily for safety reasons. However, the experimenters have learned that silicon oil was not the best choice because it can wet practically any surface and caused many clean-up problems (the experiments were in jeopardy because the astronauts were running out of paper towels).

Diffusion mechanisms in liquids must be known in order to understand the solidification mechanisms of materials. Gravity-induced thermal convection in liquids makes the determination of the diffusion mechanisms almost impossible on Earth. C. Frohberg, K.K. Kraatz, and H. Weaver (Technische Universität Berlin, Berlin) completed an experiment in Spacelab 1 using Sn^{112} and Sn^{124} tracers to study the temperature dependence of self-diffusion in liquid tin. Essentially no scatter in these data was observed; the activation energies and pre-exponential constants in the diffusion equations were accurately determined for the first time in any liquid metal. The diffusion rate under microgravity was always less than that measured on Earth, and it was measured with between 10 and 100 times the accuracy possible on Earth. Other experiments successfully determined some of the fundamental properties of liquids: capillary forces in liquids by J.F. Paddy (Kodak, Research Division, Wealdstone, Harrow, UK); dampening characteristics and resonant frequencies in liquids by H. Rodot (Centre National de la Recherche Scientifique, Meudon, France); and free surface behavior of moving liquids by J.P.B. Vreeburg (National Aerospace Laboratory, Amsterdam, The Netherlands).

The characterization of the disturbing forces on the space shuttle still needs to be completed. These forces are important in many of the experiments. V.I. Polezhaev (USSR Academy of Science, Moscow, USSR) has developed a mathematical model of microgravity aboard an unmanned Soviet satellite. The model includes the dynamics, shape, and orbit of the satellite's motion around the center of masses and the atmospheric drag forces. He presented this model and related its predictions to macro- and micro-chemical inhomogeneities at a solid/liquid interface during solidification. He showed that high-frequency convection has only a small effect on impurity distributions in the crystal but that low-frequency convection will result in a periodic variation in the impurity distribution similar to that observed on Earth in doped Si single crystals (the so-called striations in Si semiconductors). This type of modeling appears to be necessary to interpret completely the effects of the Spacelab's microgravity environment on the various experiments.

The mechanisms of phase separation in alloys where a miscibility gap exists in the liquid state were studied by

several investigators. At 1 g it has been impossible to separate and understand the fundamental forces which cause various distributions of one phase in the other. At least three factors affect the final distribution: density differences, interface surface energies, and the volume fraction of the minority phase. Experiments in space eliminate the effect of density differences, allowing the other two factors to be studied. A. Kneissel (Institut für Metallkunde, Leoben, Austria) and H. Fischmeister (Max-Planck-Institut für Metallforschung, Stuttgart, West Germany) showed that it is possible to create a fine dispersion of Pb in a Zn matrix (2 percent-5 percent Pb). The diffusion rate of liquid Pb in liquid Zn was estimated from the growth kinetics of the liquid Pb droplets to be between 5×10^{-5} and 8×10^{-5} cm^2/s at 475°C.

R. Nitsche and coworkers at the Universität Freiburg, Freiburg, West Germany, performed several very elegant experiments on crystal growth from solution. The traveling heater method was used to grow CdTe from a seed using liquid Te as a solvent and a CdTe feed rod. Unfortunately only 6 hours of the 17-hour experiment were completed due to a fault in the cooling system of the materials-science double rack. The small crystal which was grown in this time (1.5-mm thick) was badly damaged by the rapid cooling that followed the unplanned shut-down of the furnace. This experiment proved in principle that these difficult crystal-growth experiments can be performed in space. Nitsche and coworkers also grew a P doped Si crystal by the floating zone method in an attempt to discover the origin of the heterogeneous distribution of impurities (dopants) in Si single crystals grown on earth. These chemical heterogeneities are the cause of the striations observed on the surface of Si single crystals after etching. (The chemical heterogeneities in the crystal reduce its performance as a semiconductor.) After etching, the crystals were compared with "identical" crystals grown on Earth. The researchers conclude that the major striations are caused by rotating the crystal during growth (independent of gravity) and that the micro-striations are also present in both microgravity and 1-g processed nonrotated crystals. They conclude that time-dependent thermo-capillary flows driven by surface tension gradients (Marangoni flow) cause these micro-variations in the dopant concentrations. To verify this conclusion, the researchers performed a terrestrial experiment in which the liquid zone was coated with a Si oil. Since the liquid Si did not have a free surface, thermo-capillary flow was suppressed and the resulting crystal was indeed striation-free. These experiments by Nitsche are, perhaps, the best examples of how experiments in space can be used to understand fundamental mechanisms which can then be exploited on Earth.

Type III Experiments. These experiments were the least successful of the three types, probably because the first two types received more background study on Earth and in other microgravity environments (TEXUS sounding-rocket experiments). These experiments were more of a "look-see" type than truly scientific.

Many experiments on semiconductor crystal growth were performed: doped Si, II-VI, and III-V compounds. These experiments were performed in the mirror heater facility. Problems with this furnace occurred because it lacked radial uniformity in temperature and because the focal points of the double ellipsoid mirrors were not known precisely enough. However, it was shown that many different types of crystals could be grown in space--given the proper hardware to produce these crystals--and it was further shown that these crystals will have fewer defects than those grown on Earth. Bubble formation and the removal of these bubbles during crystal growth in space is a serious problem which must be considered carefully.

The creation of novel composite materials is possible by the directional solidification of eutectic alloys in space. G. Muller and P. Kyr (Universität Erlangen, Erlangen, West Germany) used InSb-NiSb as a model system for the production of a semiconductor matrix (InSb)-metal (NiSb) fibrous composite by directional solidification. It was uncertain whether gravity would influence the eutectic microstructure. The researchers conclude that gravity has a distinct influence; the directional solidification of this alloy in space has refined the microstructure (the fibers are 30 percent closer together). This difference is believed to be due to the fact that pure diffusional transport only occurs under microgravity. This finding is an important step in improving theoretical models for the growth of directionally solidified eutectics both on Earth and in space. In contrast to these results, J. Favier and J. De Goer (Centre d'Études Nucléaires de Grenoble, France) examined three different directionally solidified eutectic materials: lamellar Al-Al_2Cu, fiber-like Al_3Ni-Al, and irregular Ag-Ge. They found no microstructural differences between materials processed on Earth and in

Spacelab. These investigators believe that the seemingly contradictory results can be explained by differences in the volume changes of the two solid phases in the eutectic which occur on solidification. The spacing between the fibers may be altered by changes in the diffusion kinetics in the liquid which result from a "pumping" mechanism caused by the volume changes.

The final experiment in this category is perhaps the most successful and noteworthy of all of the materials-science experiments. W. Littke and C. John (Chemisches Laboratorium der Universität Freiburg, West Germany) have produced single crystals of two model proteins ß-galactosidase and lysozyme which are, respectively, 27 and 1000 times larger, and more perfect, than any crystals of these proteins previously grown on Earth. The significance of this result is that the crystals are large enough to perform the x-ray diffraction studies necessary to solve the puzzle of the atomic structure of these complex molecules. The great success of this experiment has convinced ESA to continue to perform similar experiments during future flights.

Conclusions

Materials processing offers great promise for the commercialization of space. However, with only a very few exceptions, commercial production is not likely to occur in this century. The greatest use of space science will be to provide insight into the important mechanisms which control the properties of materials on Earth. The microgravity environment is very useful for fundamental research on the properties of liquids and liquid/solid phase changes. The Spacelab facility has its faults, but it has demonstrated not only the feasibility but also the value of manned space science; most participants in the Spacelab 1 program feel that the astronauts were necessary (hardware problems would have prevented the execution of most experiments if the astronauts had not been there to repair and modify equipment). Perhaps the greatest disadvantage of man's presence is that much more rigid safety standards are imposed, severely restricting the types of materials which can be studied.

Europeans believe that it is crucial for Europe to keep up with the major participants in space exploitation. They believe that Europe was too conservative in the field of microelectronics, resulting in its present minor role in this field; Europeans do not want this to happen in space. Dr. H. Strub, West Germany's Federal Minister for Research and Technology, emphasized this point and also that space science will soon begin to compete for funding with other major sciences. If space science is to be successful, the taxpayers must be convinced of its value. He announced that France and Germany have reached an agreement at the President/Chancellor level to develop the HM60 engine for the French rocket-launching system. This, combined with the German/Italian *COLUMBUS* program (expected to be the European contribution to the US space-station program), will continue Europe's participation in space science (see page 109 of this issue).

The DFVLR-sponsored space shuttle flight with the Spacelab (called D1) is scheduled in 1985. It appears that it will essentially be a reflight of the Spacelab 1 experiments since the two flights are too close together for D1 to take advantage of many of the lessons learned with the Spacelab 1 flight. DFVLR is trying to arouse interest in an international (read "European") microgravity-research center at Köln, West Germany, where various special facilities for the background research supporting microgravity materials research could be performed.

The Europeans' real hope for space science hinges upon their participation (yet to be determined) in the US space-station project.

Some of the best advice offered to ESA during the meeting came from the famous Professor A. Seeger (Max-Planck-Institut, Stuttgart), an outsider to space science. (Dr. U. Merbold, one of the payload specialists on the Spacelab 1 mission, works for him.) He reminded the members of the space science community that they should review and discuss their experiments with the experts in their discipline "on Earth" because there is a wealth of knowledge that could help better select the space experiments that would be most likely to advance scientific understanding. He reminded the community that gravity is only one of many parameters which influence the properties of materials and that space simply provides a useful tool to study this parameter. Gravity should be parametrically controlled (not simply reduced to zero) in order to quantitatively study its influence.

Until the results of the D1 mission are available in mid-1986, very little new information will be produced in this field in Europe.

11/26/84

Mathematics

WORKSHOP ON LIAPUNOV EXPONENTS

by C.J. Holland. Dr. Holland is the Liaison Scientist for Applied Mathematics/Computational Science in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on reassignment until December 1985 from the Office of Naval Research, Arlington, Virginia, where he is the Deputy Division Director of the Mathematical Sciences Division.

The time-average values of the logarithms of the absolute values of certain quantities are important tools for analyzing the behavior of many deterministic and stochastic physical systems. These time-average values are commonly called Liapunov exponents for two reasons: (1) the mathematician Liapunov introduced them in the late 19th century for the stability analysis of ordinary differential equations with time periodic coefficients, and (2) the time-average values determine the exponential rate of change of the quantity.

A workshop on Liapunov Exponents with a concentration on stochastic systems was held at the University of Bremen from 12 to 15 November 1984. This meeting, attended by approximately 50 specialists, was organized by Professors Ludwig Arnold and Volker Wihstutz (University of Bremen), who are leading researchers in this area. There are plans for the proceedings to be published in a future volume of the Springer-Verlag Lecture Note Series in Mathematics.

The concept of Liapunov exponents has arisen recently in the analysis of many diverse physical models. Talks at the meeting discussed the use of these exponents in the analysis of deterministic chaos in nonlinear systems, the stability analysis of stochastic dynamical systems, and the behavior of solutions to the Schrodinger equation or wave equation with random potential, with a concentration on the last two topics, dealing with random systems. The many uses allowed an interesting interaction between mathematical physicists and system theorists. This article discusses a representative sampling of the talks at the workshop.

Researchers at Bremen (L. Arnold, H. Crauel, and V. Wihstutz) discussed their research on the use of the Liapunov exponents for the stability analysis of nonlinear stochastic dynamical systems. These systems occur frequently in modeling in various branches of engineering and physics. After linearization around the nominal solution, the mathematical problem becomes the investigation for the stability properties of the zero solution to linear systems of the form

$$x' = A(t,n(t))\,x, \qquad x(0,a) = a,$$

where n(t) is some stationary process. (As is standard in probability theory, dependence on the parameter w in the sample space has been suppressed.) The zero solution is stable if the Liapunov exponents, defined by

$$L(a) = \limsup\, [\ln |\, x(t,a)|\,]\,/t$$

as t approaches infinity, is negative with probability one for any initial random variable a. If A(t,n(t)) describes simply a constant deterministic system, then the Liapunov exponents are simply the real parts of the eigenvalues of the matrix A, and stability requires that the real parts be negative.

The Bremen researchers have concentrated on the case when the noise process is a stationary ergodic diffusion. Under certain additional assumptions, a characterization of the largest Liapunov exponent is derived. Asymptotic results for both small and large noise are also derived. The Bremen researchers have studied the canonical problem of the effect of noise on the damped linear oscillator

$$X'' + 2bx' + [k^2 + s\,n(t)]x = 0,$$

where n(t) is a stationary ergodic diffusion process with mean 0 and variance 1, k=1, and s is a strength parameter. In the case of no noise, s=0, the system is stable for positive b, with Liapunov exponents given by the real parts of $-b \pm \sqrt{(b^2-1)}$. If noise is present, they have shown that if b>1, then the maximum Liapunov exponent satisfies the perturbation expansion

$$L = -b + \sqrt{b^2-1}\; - B(b)s^2 + 0(s^3)$$

with $B(b)>0$ as $s\to 0$; hence noise increases stability for sufficiently small noise. On the other hand, if b<1, they derive another approximation, which shows that noise decreases stability if the noise is sufficiently small.

Ken Loparo of Case Western University discussed the case of the undamped oscillator b=0, where the noise process is not a diffusion process but rather is

a random telegraph process n(t) taking the values -1 and 1 with jumps between the values occurring according to an exponential distribution with mean waiting time between jumps given by 1/j. For this case it is surprising that he is able to derive an exact expression for the maximum Liapunov exponent

$$L = \frac{jks^2}{8(k^2 + j^2)}.$$

Liapunov exponents have also arisen in the analysis of the one-dimensional Schrodinger equation or wave equation with random potential. These equations arise physically from the analysis of electron properties in disordered solids, the localization of water waves by a random bottom, and sound propagation through a random medium. In this case the reduced wave operator is a random, second-order differential operator $Hx = -x''+V(t)x$ which is of the form of the equations described above. The interesting relationships, as described by B. Souillard (École Polytechnique, France) and S. Kotani (Kyoto University, Japan), are the relationships between the Liapunov exponents and the spectrum of the operator. It has been shown that if the equation $Hx+tx=0$ has a positive Liapunov exponent for all real t, then the spectrum of the operator is discrete. This is physically significant since discrete spectrum implies localization which can be used to explain, for example, the absence of electrical conductivity in disordered solids or the localization of water works in a media with rough bottom.

The analysis of Liapunov exponents is currrently an area of rich intellectual activity which has an important payoff for theoretical understanding in random wave propagation, stochastic stability theory, and chaos. Researchers at the University of Bremen are, in particular, doing excellent work in the applications to stochastic dynamical systems.

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12/5/84

Mechanics

RECEPTIVITY, TRANSITION, AND CHAOS AT NOVOSIBIRSK

by Patrick Leehey. Dr. Leehey is the Liaison Scientist for Naval Architecture and Applied Mechanics in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on leave until September 1985 from the Massachusetts Institute of Technology, where he is a Professor of Mechanical and Ocean Engineering.

The Second International Union for Theoretical and Applied Mechanics Symposium on Laminar-Turbulent transition was held in Novosibirsk, USSR, in July 1984.

Background

The International Union for Theoretical and Applied Mechanics (IUTAM) held its first symposium on the transition from laminar to turbulent flow in 1979 at Stuttgart, West Germany. Then it became evident that the Institute for Theoretical and Applied Mechanics (ITAM) of the Siberian branch of the Academy of Sciences of the USSR at Novosibirsk was an important center of research in this field. Accordingly, the next such symposium was scheduled to be held there.

The sheer logistics of this plan are impressive. Academgorodok, or "Science City" as it is sometimes called in the West, lies some 30-km south of Novosibirsk, the capital city of Siberia. Novosibirsk is four time zones east of Moscow, about halfway across the USSR. Many of the participants were met on entry in the Soviet Union by scientists from ITAM. This meant simultaneous welcomings in Moscow and in Vladivostok! Fortunately, few chose the trans-Siberian railway for the trip--a 10-day round trip at best.

Sadly, N.N. Yanenko, chairman of the IUTAM scientific committee, died during the planning stages for this meeting. The actual operation of the symposium was in the capable hands of V.V. Kozlov, but also many of the scientific staff of ITAM worked very hard to make the symposium a success. Their efforts went beyond the meeting itself; a number of us were accompanied back to Moscow and aided in arranging visits to institutes there.

Since the proceedings of this symposium will be published by Springer-Verlag, Berlin, this summer, I shall

report here only on those portions of the symposium which were of greatest interest--at least to me. References are not given. For specifics, consult papers by authors cited below in the *Proceedings of the First Symposium on Laminar-Turbulent Transition, Stuttgart, 1979* (Berlin: Springer-Verlag) and volumes of the *Journal of Fluid Mechanics* for the period between the two symposia.

Receptivity

The term "receptivity" was chosen by Mark Morkovin of the Illinois Institute of Technology to denote the response of a laminar flow to external disturbances. Most laminar shear flows can develop growing travelling waves, known as Tollmien-Schlichting (TS) waves after the two investigators who first predicted their existence. Such instability waves must develop from some initial excitation. Receptivity is, in general terms, the ratio of a TS response velocity to an appropriate excitation velocity. Variations in external excitation are responsible for the so-called "unit Reynolds number" effect reported from various wind tunnels.

Considerable progress has been made on the experimental determination of receptivity of laminar boundary layers since the first symposium. V.Ya. Levchenko of ITAM reported that his findings now agree with those of my group at the Massachusetts Institute of Technology (MIT). Receptivities of order 1 to sound waves are found without the need for an intermediate transfer of energy to panel vibration adjacent to the boundary layer. I showed that properly phased panel vibration could be used to cancel the effects of sound excitation, restoring natural transition. V.M. Giljev of ITAM reported the results of similar experiments where TS waves created by a vibrating ribbon could be reinforced or cancelled by shifting the phase of a vibrator located in the wall downstream of the ribbon.

Prior to this meeting, both analytical and numerical predictions of the receptivity of a laminar boundary layer to downstream travelling sound waves were several orders of magnitude too low. New theoretical results presented at the meeting show promise of resolving this dilemma. A.V. Fedorov of the Moscow Physical-technical Institute gave his analysis of the receptivity of a compressible subsonic laminar boundary layer to acoustic disturbances. He considered two mechanisms for exciting TS waves. The first is the nonparallelism of the boundary layer. This alone provided an excitation of TS waves localized near the leading edge but extending past Branch I of the neutral stability curve for the case considered. More effective excitation was obtained when a surface waviness was assumed. He stated that his results agreed with experiments of L.B. Aizin and N.F. Polyakov of ITAM for the incompressible limit; however, details of the wall waviness were not given. Apparently only amplitudes very much less than a viscous sublayer thickness are necessary.

E.D. Terent'ev of the Computing Center of the Academy of Sciences, Moscow, determined the response of the boundary layer to a small triangular vibrator located far from the flat plate leading edge. His asymptotic analysis for large Reynolds number is of the triple deck type. What appears essential is that there is some spatial scale of the excitation or of the mean flow (e.g., the pressure gradient) that matches the appropriate TS wavelength so that a high receptivity results. Our own experiments at MIT, reported at the meeting, bear this out quite conclusively in the case of zero pressure gradient--obtained when the test plate is given a slight negative angle of attack. Here the receptivity to downstream travelling sound waves is experimentally nil, corresponding to and justifying the earlier theoretical results. On the other hand, the adverse pressure gradient of short length scale formed at zero angle of attack provokes a receptivity of order 1.

Transition

Transition from laminar to turbulent flow follows the reception phase discussed above. Reception is a linear process; transition is inherently nonlinear. It has become clear from experiments, largely conducted in the period between the two symposia, that there are at least two basically different forms of transition from laminar to turbulent flow in boundary layers. The classical form is that reported by Klebanoff, Tidstrom, and Sargent in 1962. They found that both the mean and unsteady flows developed spanwise periodicities. Shortly thereafter the unsteady flow, composed of TS wave packets, broke down catastrophically to form turbulent spots. The spot patterns followed each other in nearly regular downstream-directed rows.

A different type of transition has been observed by Yu.S. Kachanov and V.Ya. Levchenko at ITAM and at the Virginia Polytechnic Institute (VPI) by W.S. Saric and his coworkers. Here a half-frequency subharmonic interacts with the principal TS wave to produce a

more gradual transition to turbulence. Three-dimensionality plays a role here as well. The spot patterns alternate in their downstream development, reflecting the doubled wave length of the subharmonic.

Although both types of transition are usually generated by vibrating a thin ribbon stretched spanwise across the boundary layer upstream of the measurement zone, the Klebanoff type was generated by placing pieces of tape under the wire at regular intervals to emphasize spanwise periodicity. The wire itself was driven by a strong pure tone. In the Kachanov/Saric experiments, the wire was driven at a weak pure tone and no lateral spacers were used. In some Saric experiments a half-frequency subharmonic was simultaneously introduced into the ribbon vibration. In the Kachanov experiments, however, it was simply present in the stream turbulence spectrum.

Several theoretical and computational papers were presented at the meeting. Primarily they were devoted to explaining the Kachanov/Saric form of transition. On the surface, the issues appear a bit confusing because both forms of transition are discussed in terms of a triad of interacting waves first introduced by A.D.D. Craik of the University of St. Andrews, Scotland, as a possible means for explaining Klebanoff transition. Such a triad of waves travelling at the same wave speed consists of one planar wave of a given frequency f plus two opposing oblique waves of frequency f/2. In the Klebanoff case the ribbon frequency is f/2, whereas in the Kachanov/Saric case the ribbon frequency is f. T. Herbert of VPI, using a spectral collocation numerical method, finds the Kachanov/Saric case to be a parametric excitation of subharmonics of a weakly nonlinear primary TS wave.

I.I. Maslennikova and M.B. Zelman of ITAM made computations yielding essentially the same conclusions as those of Herbert for the Kachanov/Saric transition. They also conclude that a Craik resonance model is inadequate to explain Klebanoff transition. Somewhat similar results, but for plane Poiseuille flow, were obtained by L. Kleiser and E. Laurien of the Deutsche Forschungs- und Versuchsanstalt für Luft-und Raumfahrt, Institut für Theoretische Strömungsmechanik, Göttingen, West Germany. Kleiser and Laurien performed numerical experiments to cancel TS waves and predicted that substantial delays in transition are, in principle, possible.

M. Nishioka and M. Asai of the University of Osaka Prefecture gave experimental results for the nonlinear growth of ribbon excited TS waves in plane Poiseuille flow which agree with earlier numerical calculations of Herbert involving parametric excitation and subharmonic oscillations.

Thus it appears that in spite of the very substantial progress made in understanding Kachanov/Saric transition, we have not yet succeeded in uncovering the basic mechanism of the older Klebanoff transition. It is also likely that we have not yet found experimentally all of the important forms of transition. For example, V.N. Zhigulev and N.V. Sidorenko of the Moscow Physical-technical Institute predict by an asymptotic analysis that the linear stage of disturbance development will be bypassed if the intensity of stream turbulence exceeds a certain threshold level. This level is, in turn, determined by the wave number of the most dangerous excitation and the local Reynolds number.

Shear-Flow Calculations by the Spectral Collocation Method

It was quite evident at this symposium that the preferred method for calculation of high-Reynolds-number flows is that of spectral collocation (more properly, pseudo-spectral, since the governing equations are nonlinear). This method was used for the transition calculations of Herbert and of Kleiser and Laurien noted above. Expansions in Chebyshev polynomials for the coordinate normal to a wall are used, preceded by a mapping in the boundary layer case in order to reduce the flow to a bounded domain.

B.L. Rozhdestvensky of the Keldysh Institute of Applied Mathematics of the Academy of Sciences, Moscow, used this method for an initial Poiseuille flow well beyond the transition regime. He found three-dimensional "secondary flows" whose mean properties, such as the coefficient of friction at a wall, compared well with experimental data for fully developed turbulent flows at the same Reynolds numbers. He is careful, however, to distinguish his computed flows from turbulent flows. As best I can judge, the distinction is simply that a "secondary flow" is a computed flow whereas a "turbulent flow" is a measured flow. Rozhdestvensky defines "secondary flows" as those with stationary integral characteristics, ignoring the fact that all measurements of flows involve some integration! In a separate discussion with me, he stated that one must be careful to carry out such calculations for a sufficiently long time; otherwise, initial data that are too close to an unstable state may briefly provoke what would appear to be a

turbulent flow only to die out later in the calculation.

Chaos

Chaos in a dynamical system may be roughly described as a high degree of complexity which develops in a deterministic way from specific initial conditions but which changes its appearance drastically under slight changes in the initial data. One approach to chaos is via successive period doublings. We have seen that such doubling occurs at least once in the Kachanov/Saric form of transition. It is therefore not surprising that a number of papers at this symposium dealt with chaotic descriptions of transition to turbulence. Most of the papers dealt with forms of transition other than those occurring in laminar boundary layers. (For French work on chaos, see *ESN* 39-1:21-23 [1985].)

K. Buehler and J. Zierep of Karlsruhe University, West Germany, described experiments where turbulence is developed in the flow between two concentric spheres. For instance, when the outer sphere is fixed but the inner sphere is suddenly rotated to a high supercritical Reynolds number, turbulence is "spontaneously" created next to the equator. The turbulence front then moves toward the poles with a definite velocity. Yu.N. Belysev, S.V. Makarychev, A.A. Monakhov, and S.A. Scherbakov at the Moscow State University described similar experiments involving sequences of period doublings and a final transition to a nonperiodic state resulting from the development of a strange attractor at a particular Reynolds number. E. Palm, A. Skogvang, and M. Tveitereid of the University of Oslo gave an analysis of transition to chaos for thermal convection at low Prandtl number.

It is a major step to go from these simpler flows to boundary layer transition. M.A. Golshtik, A.M. Lifshitz, and V.N. Shtern of the Institute of Thermophysics, Novosibirsk, make significant progress along this way in their analysis of threshold regimes for plane Poiseuille flow. Their work involves Craik triads and appears similar to that of Kleiser and Laurien. For subcritical bifurcation, they find a limiting value of 678 for the Reynolds number of transition with increasing level of excitation. This figure is close to that found experimentally.

The theory of the approach to chaos certainly will be applicable to the problem of laminar boundary layer transition, but somehow it must cope with two developments which presently seem foreign to its basic philosophy. One is the receptivity issue. If receptivity is significant, and other evidence discussed her says that it is, then insensitivity to spatial initial data cannot hold. The other issue is that of turbulence regeneration through the mechanism of sublayer bursting--a well-established experimental fact. On the face of it, such organized behavior in the fully turbulent boundary layer seems outside the realm of current theories of chaos.

Concluding Remarks

In order to present a fairly cohesive picture of the central theme of the symposium, many interesting papers have been omitted. These include reports on the development of turbulent spots, on the effect of cooling upon supersonic boundary layer transition, and on transition on swept wings. Scientists in the USSR, particularly at Novosibirsk and Moscow, are making impressive contributions to our understanding of laminar-turbulent transition. This is evidenced by their many papers in all aspects of the problem--even when allowances are made for the home court advantage.

12/18/84

Physics

MANCHESTER, A NEW KIND OF UNIVERSITY TOWN: INSTITUTIONS AND FACILITIES

by Paul Roman. Dr. Roman is the Liaison Scientist for Physics in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on assignment until September 1987.

We are accustomed to associating names like Cambridge, Oxford, Bologna, and Heidelberg with places where the town's fame derives from and its focal activities are associated with an ancient and still-flourishing center of advanced learning. Less well known and appreciated is the close linkage between a town and its university and colleges when the development is more recent.

In fact, "provincial" English universities are (somewhat condescendingly) often called "redbrick universities," and until recently it was also customary to (at least inwardly) comment that, alas, those red bricks are all covered with black soot. With the rapid changes

that have taken place in the UK during the past 25 years and with the urgency of programs for scientific and technical renewal, this kind of attitude is becoming old hat--notwithstanding the economic problems of the recent past and the present. It appears that new structures--new kinds of university towns--are emerging; the only very recent American emphasis on "university-industry-government" tripartite development and support seems to have been anticipated in England for some years. A case in point is the old northwestern civic and industrial center, Manchester.

Owen's College, founded in the first half of the 19th century was the core of the future development. It soon became the Victoria University of Manchester, which indeed showed occasional excellence in some fields. For example, to mention only a haphazard selection of luminaries in physics, names such as Rutherford, Blackett, and Rosenfeld were associated with the university in the first half of our century. But somehow the institution never quite assumed a focal position.

Change came on several fronts. The Manchester Institute of Science and Technology, originally a small technical school, became associated with the university about 80 years ago, but few people working at either institution were truly aware of this link--until the 1960s. Then two major developments occurred. First, governmental and private funding led to a rapid building program for the university; what originally consisted of a few closely tied, somewhat outdated two- and three-story buildings transformed itself into a vast area of modern, functional, and pleasing tall structures. Their construction was a major stimulus to urban renewal as well.

At the same time, the institute of technology was joined to Manchester University with strong ties. It became known as the University of Manchester Institute of Science and Technology (UMIST). While it has its own vice chancellor and a separate budget, the faculty of the University of Manchester and UMIST is represented together in the University Senate, and, for example, new programs are approved by the entire conglomerate. UMIST itself attracted an influx of funds and is now what for an outsider may seem a large, self-contained, technically oriented university occupying substantial areas where, earlier, dismal buildings stood.

Another source of the transformation of Manchester into a formidable center for advanced learning was the establishment by the government, in the late sixties, of a chain of polytechnics. These institutions--although considered in principle "teaching institutions" giving bachelor's degrees in "philosophy" and some specific engineering diplomas--also conduct widely based research. Most of them also run postgraduate programs leading to master's and PhD degrees. (These programs must be approved by a university; external examiners are required, and the degree is formally granted by the University.) Manchester Polytechnic, with its fine facilities, is cooperating well with the University of Manchester and UMIST, and adds a special flavor to the atmosphere of scholarly pursuits adapted to its special role and somewhat limited resources.

The picture is further enhanced by a somewhat unusual, but for us most topical, feature: the powerful resources associated with VUMAN Ltd., a holding company whose shares are (at this writing) all owned by the University of Manchester. The company has several divisions or daughter companies: Computers--scientific word processing; Robotics--chemical analysis; "Medival"--evaluation of pharmaceuticals; Industrial Systems--software for production lines; and Lasers. These divisions are headed by scientists. They do both basic research and development (often in close cooperation with the University of Manchester or UMIST people) and also fabrication and marketing. All profits go to the University of Manchester system. The idea of such a symbiosis between a university and a semicommercial outfit, although not entirely unique to Manchester, deserves serious consideration by American universities.

The picture of university life in Manchester would be incomplete without talking of Salford University. This modern campus (practically adjacent to the City of Manchester) evolved from an institute of technology some 20 years ago. After a rapid and successful development, it was quite recently severely hit by funding cuts. The idea was to reshape the institution by expecting it to set up substantial collaborative projects with independent industry ("sunrise projects"). The engineering departments adjusted quite well. Robotics, in the Aeronautical and Mechanical Engineering Department, as well as control systems, information technology, thin films and surfaces (in cooperation with the solid state physicists) in the Electrical Engineering Department are recognized areas of prominent research, and some of the work has unusual features not pursued elsewhere. Some other departments were traumatized and have not yet found new directions. For example,

the Physics Department was reduced from 34 to 18 faculty in the period 1981-84 and dropped, among other projects, interesting basic research in magneto-optics. But even though projects such as magnetic separation in industrial settings predominate, basic research on magnetic structure, magnetostriction, and behavior of amorphous materials continues and deserves watching.

In summary, the inquiring visitor to Manchester will find a vigorous, diversified, cooperating community of scholars, teachers, applied researchers, technologists and industry which imprints its character on the town.

The next article in this issue deals with laser research in Manchester; the article on page 105 concerns electro-optics. The note on page 121 focuses on a new initiative in artificial intelligence at UMIST.

12/4/84

MANCHESTER, A NEW KIND OF UNIVERSITY TOWN: LASER RESEARCH

by Paul Roman.

Significant work in various aspects of advanced laser research is done in the Physics Department of the University of Manchester, at VUMAN Lasers Ltd., and in the Department of Pure and Applied Physics at UMIST. (The preceding article discusses the general characteristics of these organizations.)

University of Manchester

Professor T.A. King leads a group of 14 researchers; some of their work is described below.

Nonlinear Optics and Coherent Transients. This work receives substantial external support from the Science and Engineering Research Council of the UK, VUMAN Ltd., and British Telecom. It focuses on the study of coherent interaction of laser radiation with atomic systems by studying pulse propagation and amplification, with a view to advanced laser techniques. Probably the most exciting results were recently achieved in the area of phase conjugation by degenerate four-wave mixing (DFWM). King and A.C. Cefalas (now back at the Theoretical and Physical Chemistry Institute, NHRF, Athens, Greece) observed phase conjugation at 193 nm by DFWM in an inverted excimer ArF amplifier. The scheme of the experiment is shown in Figure 1. Population inversion was achieved either by e-beam excitation or by incoherent photon pumping. This is an innovation in itself; in the very few previous studies of this kind, absorbing media were used, which led to loss of output. Pump beam 2 in Figure 1 was obtained by reflecting back into the medium pump beam 1. The probe beam was derived from the same laser source as the pump beams. The active overlap length was 5 cm, and the amplification length of the phase conjugation wave inside the cell was 40 cm. A maximum reflectivity of 15 percent was achieved, much higher than previously reported. In addition, a pulse compression by more than 66 percent was observed.

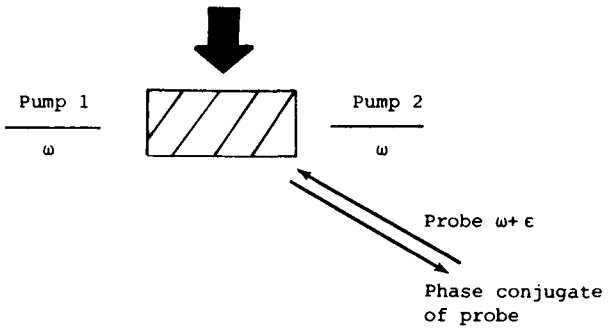

Figure 1. DFWM experiment.

Closely related are previous studies by King's group on coherent resonant self-focusing, super-radiance, and self-induced transparency. These phenomena have important technical implications for active pulse shaping in high-power laser systems. For example, the group succeeded recently in demonstrating super-radiance in photo-dissociatively created systems, for both visible and infrared transitions. Apparently, this is another first by this group. Self-induced transparency on a Q(2) degenerate magnetic dipole transition has also been observed by Drs. King, Bannister, and Gan Xu very recently, before other researchers in the field. They concluded that self-induced transparency exists in any degenerate two-level system, provided that suitable polarization of radiation is used. In the last few months they have extended their work to cover pulse areas up to 4π. They have shown that laser pulses of various areas are reshaped considerably by the coherent field-matter interaction. Pulses have been found to narrow by two-thirds for a 3π pulse. Finally, they have demonstrated the usefulness of self-induced transparency for the measurements of transitional dipole moment and homogeneous relaxation time.

Novel Metal Vapor Gas Lasers. One interesting project in this field, brought to fruition a year ago, was the development of a DC-excited, optically pumped, visible wavelength atomic mercury laser. Pumping was done by a mercury arc lamp at two different wavelengths, and molecular nitrogen was used both to link the pump stages and to drain the lower laser level by inelastic collisions. The laser was of all-silica construction, with a 3-mm-diameter tube, terminating in Brewster windows and having an active length of 90 cm.

Exploratory work on other metal vapor lasers is now in progress. This is a rather unexplored area of great importance, partly because it may lead to sophisticated laser systems.

Atomic Iodine Laser. High power (megawatts) and a high repetition rate are required for coherent transients research and terawatt, short-pulse, high-energy lasers are needed for laser fusion studies (plasma diagnostics). These requirements led King's group to develop a stable, easy-to-operate, mass-manufacturable atomic iodine photo-dissociation laser (IPL) for both scientific and commercial applications. Systematic studies in this area began in 1970 at the Max-Planck-Institut in Garching, West Germany. The Manchester University group (J.J. Baker and King) started to contribute significant developments in 1976 at the same time that workers at the Lebedev Institute, Leningrad, USSR, published some results. Sandia National Laboratory joined the field in 1978.

The IPL is lasing between the $5^2P_{1/2} \longrightarrow 5^2P_{3/2}$ atomic iodine states at a wavelength of 1.315 μm. The excited states of iodine are produced by a flashlamp pump, via the ultraviolet (UV) flash photolysis of various perfluoroalkyl iodides, primarily C_3F_7I. The processes inherent in the action of the IPL are:

$$\text{Excitation: } C_3F_7I+h\nu \text{ (pump)} \longrightarrow C_3F_7I+I^*,$$

$$\text{Laser action: } I^* \longrightarrow I+h\nu \text{ (laser)}.$$

After laser action occurs, most of the molecular fragments recombine to form the parent compound:

$$C_3F_7+I+C_3F_7I \longrightarrow C_3F_7I+C_3F_7I$$

which is a rapid reaction that avoids bottlenecking in the $5^2P_{3/2}$ state. Although many other reactions occur as well, the overall lasing process can be described by the four-level scheme shown in Figure 2.

The group had to overcome many technical problems to construct an easy-to-operate, reliable IPS. This work was completed in cooperation with VUMAN Ltd. The current high-repetition-rate IPL system they developed permits easy gas control with no vacuum system required. The tube consists of a sealed, all-glass, thermal cycle module with no mechanically moving parts. A charge of liquid laser material is held in an evaporation chamber; the gas is evaporated through the excited region, recondensed, and circulated back into the reservoir. The pressure is controlled by the condenser's temperature, and the flow rate is determined simply by the power dissipation in the heater. The strongly quenching I_2 (which is produced by some of the minor reactions) must not be recycled. This is achieved by trapping the I_2 in solution in the liquid-phase perfluoro alkyliodide, at temperatures less than -5°C. The most popular version of this system has repetition rates up to 10 Hz and provides stable outputs for up to 10^6 shots. In the

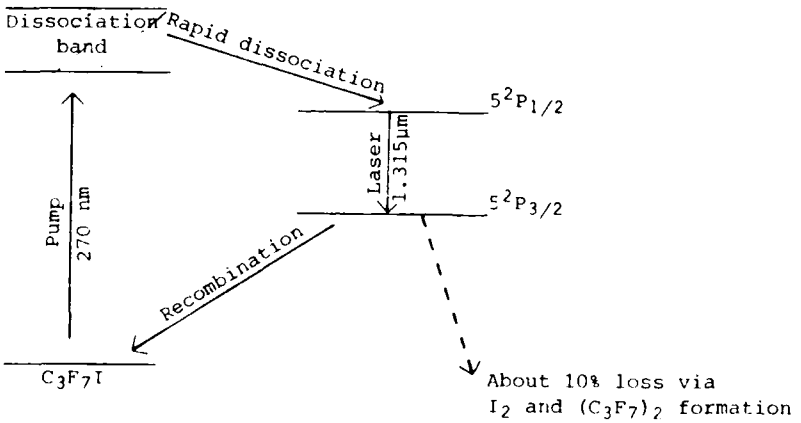

Figure 2. Level system.

simplest configuration the pulse length is 3 to 6 μs with a pulse energy of 1 to 5 J, but by scaling up the laser aperture and pumping power, 50 J and larger energies can easily be produced. Furthermore, using acousto-optic or electro-optic active switching, standard off-the-shelf models can be Q-switched or mode locked and, for example, a 16-mm aperture laser will produce 1- to 20-ns pulses up to 1 J. Finally, by adding buffer gases (such as argon at 5 atm), 100- to 150-ps pulses can be obtained. Research is now in progress to apply a new type of pumping (low-pressure mercury lamps) and to introduce new laser molecules with better recombination rates, lower dimerization rates, and broader photolysis bands centered at longer wavelength. Among other advantages, these developments would allow for solar-pumped iodine lasers.

Mercury Halide Excimers. Whereas HgBr lasers (noted for their "blue-green" light important for underwater communication) have been described before in some detail and HgCl or HgI laser action has been observed, King's group is the first to achieve and study sustained and stable lasing for all four halogens, I, Br, Cl, and F. The basic mechanism is to use the visible vibrational-rotational transitions for the B ⟶ X electronic configurations of the Hg- halides. The excited B state HgZ* (where Z=I, Br, Cl, F) is produced by a UV preionized transverse discharge photo-excitation followed by dissociation:

$$HgZ_2 + h\nu \longrightarrow HgZ^* + Z.$$

The laser transitions occur between a large number of upper and lower vibronic levels, the former being low levels in the B-state, the latter very high levels in the X-state. Figure 3 illustrates the basic properties of the transitions. The operation between the various levels occurs both simultaneously and separately by tuning. In addition, King and F. Kvasnik observed an overlapping broadband continuum laser emission, which is rather unexpected for gases. This comes about by bound-free transitions, due to a variety of mechanisms.

The authors observed laser action over a wide range of operational conditions. They found, among other things, that the laser output spectra are independent of the operational conditions, and they managed laser action at surprisingly low total gas pressures. For the first time in the literature, they demonstrated tuning in detail. Tuning was achieved, of course, by using the rotational-vibrational structures and employing in-cavity filtering or Fabry-

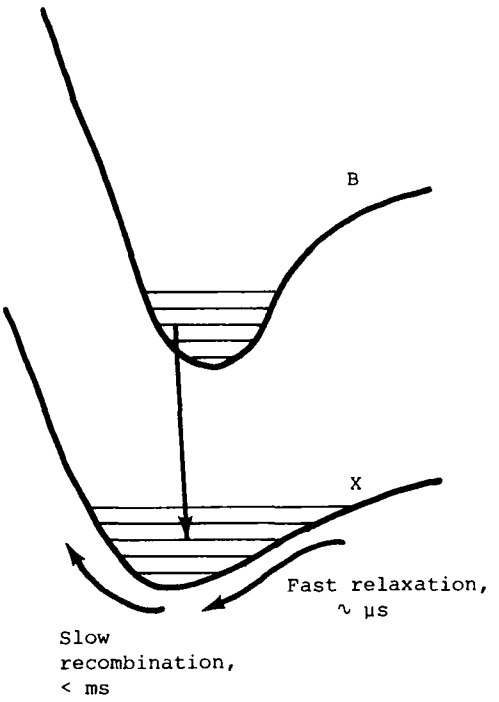

Figure 3. Properties of transition.

Perot interferometry. They also noted that the addition of N_2 to the buffer gas improves performance. The underlying mechanism is only partially understood. Table 1 summarizes the principal achievements. Work on the HgF laser is not yet complete.

King points out that since the devices are volume-scalable, it should be possible to produce high energy and effectively tunable lasers with very long lifetimes. Apart from the obvious blue-green applications of the HgBr laser, this may be of significance for pumping the red end of dye lasers with a HgF laser and for doing very effective photoresist manipulation with the blue HgI laser.

Advanced Pulse Forming Techniques. To use lasers efficiently in many practical applications, it is necessary to possess special methods for enhancing the operation and shaping of the output. The University of Manchester physics group has fine results in this area as well. For example, realizing that good preionization results in better impedance matching between the pulse forming network and the laser plasma, King and Cefalas devised a highly effective double preionized ArF excimer laser, using a pulse forming network with an LC-inversion circuit totally enclosed inside the laser volume. In another effort within the area of subnanosecond

DFVLR Research Departments

The following paragraphs briefly describe the Project Management Department and the varied aspects of research at the five major research departments.

The Project Management Department is responsible for all tasks associated with DFVLR's engagement as the project executive organization for government-sponsored programs. Additionally, the Project Management Department assists the government upon request by assuming project management responsibilities or project support tasks as well as providing technical advice and services. The Project Management Department acts on behalf of the Federal Minister for Research and Technology (BMFT) and, within limits of appropriations, awards contracts, or grants, or both, to industrial firms and scientific establishments. Such research and development work is supervised by this department, and technical results are assessed and analyzed in order to make recommendations to the BMFT about continuing such scientific effort. The objectives of individual projects under the government research program are coordinated to help prevent duplication of work being done by other institutions handling related research projects on a European or international level. The extent of collaboration, depending on the scope of interest, is defined and may go as far as direct participation in a cooperative project, such as projects ongoing with the US National Aeronautics and Space Administration related to space research and exploration. The following are other examples of projects that the department manages:

- Extraterrestrial research projects.
- Use of the European space laboratory, Spacelab.
- Projects in the fields of telecommunications and data processing.
- Development and manufacture of communications satellites.

The Research Department for Flight Mechanics/Guidance and Control has its headquarters in Braunschweig. This department's research activities are directed primarily toward solving the problems associated with vehicle movement: dynamics, guidance, and control. Both military and civilian requirements for transporting payloads are modeled and analyzed. Airplanes, helicopters, missiles, ships, trains, rockets, and space probes are used as payload transport vehicles, which may be either manually or automatically controlled and guided. The researchers must solve problems of system and mission analysis; of optimization, regulation, and simulation; of the man-machine environmental system; of location and navigation; and of evaluation of the system design. The problems of propulsion, structure, and fluid mechanics are not addressed in this department, however. There is a close cooperation between the Research Department for Flight Mechanics/Guidance and Control and the Braunschweig Technical University.

The Research Department for Fluid Mechanics has its headquarters in Göttingen. Both theoretical and experimental fluid mechanics research is conducted at the Institute for Theoretical Fluid Mechanics and the Institute for Experimental Fluid Mechanics in Göttingen. The classical questions concerning problems of fluid mechanics relative to optimizing the design of aircraft and ground vehicles are receiving continued emphasis, while fluid-mechanical problems introduced by space technology have contributed to a natural expansion in this area of research. Parallel to work on the external design of aircraft and space components, research is conducted regarding the internal design of turbomachinery engines and their integration into complete vehicle systems; at the same time this research attempts to limit environmental pollution as much as possible. The knowledge acquired through new theoretical calculation procedures as well as new experimental measuring techniques is being applied increasingly to the large field of industrial process technology. The Research Department for Fluid Mechanics uses a variety of research facilities, including wind tunnels and test stands that are operated throughout the year by personnel from the technical facilities and services departments.

The Research Department for Materials and Structures has its headquarters in Stuttgart. The researchers investigate and develop structures which guarantee sufficient safety for man and equipment in every operational environment and situation, even under extreme conditions. The properties of suitable materials--such as fiber-reinforced composites--are analyzed and improved, and optimum design principles are investigated. This department also deals with the research of advanced materials for future turbine systems to provide improved efficiency and reduced pollution while operating at extremely high temperatures. Suitable design principles are also the object of research on superalloys, fiber-reinforced metals, and ceramics for these high-strength, high-temperature applications. Research is also focused on the interaction

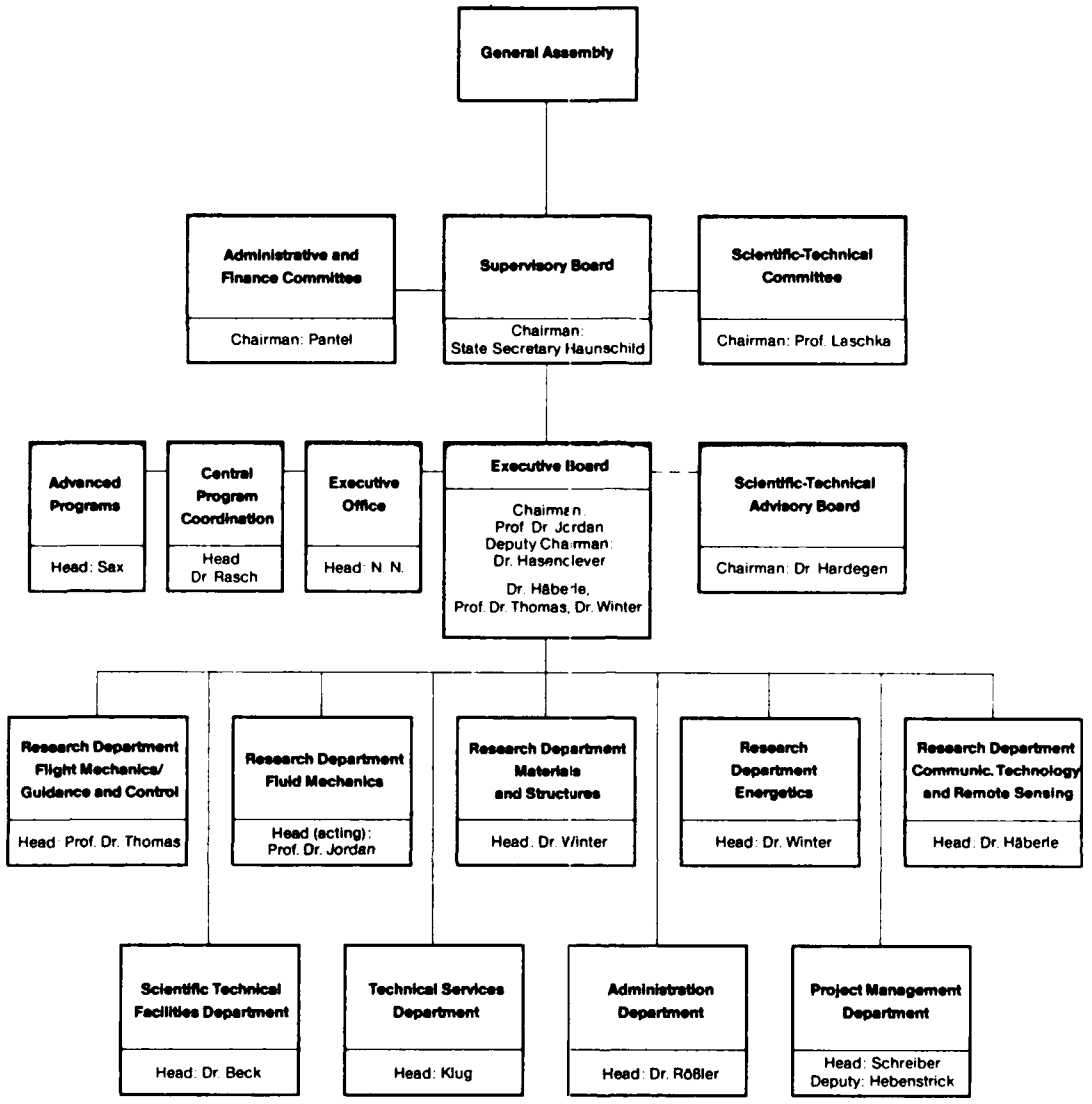

Figure 1. DFVLR organization.

shown, with each department having three to five research institutes within its purview. Although some of the departments, such as the Research Department for Communications Technology and Remote Sensing, have all of their associated research institutes in one location, in this case at Oberpfaffenhofen, other research departments may have their associated institutes in various locations. Additionally, there are technical facilities and services departments at Oberpfaffenhofen; the Project Management Department is in Cologne.

This overall DFVLR organization is supported by a staff of approximately 3200 personnel, of which over half are scientists and scientific or technical assistants working within these five research departments, the technical facilities and services departments, and the Project Management Department. DFVLR has many modern and advanced test facilities available at its various technical installations. Examples of these facilities include:

- Wind tunnels for subsonic to hypersonic speeds.
- Test stands for aircraft and rocket engines.
- Test beds and experimental aircraft as well as ground and airborne simulators.
- Spacecraft data receiving and command stations.
- Mobile launch facilities for sounding rockets.
- Space simulation chambers of various sizes.

Yugoslavia, the UK, Poland, West Germany, France, Greece, Italy, Austria, Switzerland, Portugal, and Spain. Prior to the USSR's joining FASE, the combined membership of the 25 national societies was about 6000 (almost the same as the Acoustical Society of America [ASA]), ranging from about 50 members in several countries to 1000 or more in the UK, France, and West Germany.

The major work of FASE is to cosponsor (with national societies) congresses and symposia. Although FASE covers all of the broad field of acoustics, each congress emphasizes only two or three topics and each symposium only a single topic. This is in marked contrast with meetings of the ASA, which cover all topics in the field. Congresses are held every 3 years, while symposia are held on most of the other years. It should be noted that a large number of other acoustical meetings are held in Europe (usually organized by one or two countries) which do not involve FASE sponsorship. FASE does not publish an acoustical journal, but it does have an excellent policy of publishing the proceedings of congresses and symposia. Normally these proceedings are available at the times of the meetings. FASE is governed by a council composed of one representative from each country. Officers (president, vice-president, and secretary) serve 3-year terms which run from one congress to the next. Professor Brian L. Clarkson (University College of Swansea, Wales) is the recent past president, and Andres Lara-Saenz (Spain) is the newly elected president. Professor Felix Kohmer (Czechoslovakia) has been secretary since the founding of FASE, and he will continue to serve for another term. FASE, in addition to sponsoring technical meetings, has several ongoing projects, each of which is handled by a working group. For example, they have compiled a listing of educational programs in acoustics in European universities. Currently they are working on assembling summaries and listings of research and development activities in member countries. Also they are working on compiling information on teaching aids for acoustics (e.g., films, demonstrations, and experiments). On this last project, FASE is very keen to work with the ASA committee on Education in Acoustics. FASE and the ASA have an official agreement by which each group is invited to have a representative attend the council meetings of the other group. This plan has been in operation for several years and seems to work well and to be useful to both organizations.

12/13/84

WEST GERMANY'S DFVLR HANDLES WIDE RANGE OF AEROSPACE RESEARCH

by CDR L. Laddie Coburn, USN, and C.J. Holland. CDR Coburn is the Director of the Naval Applications Division and the Aerospace Systems Officer for military aircraft research and technology in Europe and the Middle East for the Office of Naval Research's London Branch Office. Dr. Holland is the Liaison Scientist for Applied Mathematics/Computational Science in Europe and the Middle East for that office; he is on reassignment until December 1985 from the Office of Naval Research, Arlington, Virginia, where he is the Deputy Division Director of the Mathematical Sciences Division.

Deutsche Forschungs-und Versuchsanstalt für Luft-und Raumfahrt (DFVLR) is the largest research establishment for aircraft and aerospace research and engineering sciences in West Germany. This article first generally discusses DFVLR's organization and policy, and the research at the various DFVLR research institutes; then the article looks in detail at the Institute for Flight Systems Dynamics at Oberpfaffenhofen, near Munich.

Overall Organization

DFVLR has 20 separate research institutes located in Braunschweig, Göttingen, Cologne-Porz, Stuttgart, and Oberpfaffenhofen. Each of these institutes is primarily financed through government funding. The government objectives for DFVLR are to provide research, mainly in the aerospace field; to participate in the planning and realization of research projects; to construct and operate large-scale testing facilities to support such research; to promote training of junior scientists; and to provide assistance and technical advice to federal government authorities. The technical knowledge acquired and the technologies developed in the aerospace research areas are, to a significant extent, also applied in other technical engineering or scientific areas of governmental interest, such as development of advanced transportation and communications systems, non-nuclear energetics, and improvement of living conditions.

The overall organization is governed by a supervisory board and an executive board with various committees and staffs to support management of the DFVLR research and operations. The executive board is also supported by a scientific and technical advisory board, as shown in Figure 1.

The DFVLR organization is divided into five major research departments, as

other kind in England?) present a worse noise problem than do oil and gas operations.

Paolo Cielo (National Research Council, Quebec, Canada) described the use of ultrasonic convergent waves for nondestructive evaluation of solids. A pulsed laser beam and a special lens are used to form an annulus of incident light on the surface of a material to be inspected. The light pulse generates a thermoelastic pulse which propagates as both bulk and surface waves. Surface waves propagating toward the center of the annulus become more intense toward the center point of focus. Vibration of the surface modulates the beam of a second laser, which is focused at the center of the annulus. This modulated, reflected, laser beam is detected. The characteristic which is monitored is acoustic surface wave velocity. Anomalies near the surface distort the surface wave. The system is used to test for cracks, flaws in bonding of surface coatings, and other surface layer defects. The diameter of the annulus typically is 1 to 2 cm, but can be varied from 10 cm to 1 mm to suit the application. Pulse lengths are typically 10 ns.

W. Van der Linden (Ministry of Housing, Physical Planning, and Environmental Protection, The Netherlands) gave an excellent invited paper on his government's long-term program for noise reduction in the residences and other buildings. The Netherlands has a high population density, and all real estate must be used. Over 390,000 houses are exposed to high noise levels along roads and near industry (65 to 80 dBA) and along airfields (80 to 100 dBA), with about three times as many above 50 dBA. Since 1974 the government has had a program, in 5-year increments, to provide better insulation in houses to reduce the noise level and at the same time provide energy conservation and good ventilation. Techniques include double glazing, silent ventilation boxes around windows, and other proven techniques. The important point is that government regulations require that suitable construction methods be followed. Government subsidies help make the added costs more acceptable. The program is expected to run 25 or 30 years and covers both new construction and modification of existing structures. Approximately 15,000 dwellings each year are included in the program.

The final plenary paper of the congress, given by Ted Schultz (Theodore J. Schultz Associates, US) proved to be a bonus: he published in the proceedings an excellent survey paper on special problems in community-noise rating, but presented at the meeting an entirely different paper on prediction of sound-pressure levels in offices, residential rooms, and similar small-volume enclosures. He discussed the relation between source power level and sound-pressure levels. The diffuse field theory does not seem to hold in practice for these sizes of rooms. He summarized the results of an extensive series of measurements in 11 different rooms using a variety of household appliances for noise sources. No simple model seems to hold; different sources and different room sizes have different effects, but Schultz gave empirical relations. However, he cautioned that these relations might well not hold for rooms significantly larger than the ones he studied.

Proceedings

The papers I have discussed are only a small sample of those presented, but they are representative. The proceedings of the congress have been published in a 614-page volume. The lengths of the papers run from 4 to 16 pages. The proceedings give one a good survey of current work, largely European, in the areas covered by the congress. For information on obtaining the proceedings, write to Jan Tro (Editor), FASE 84, ELAB, N-7034 Trondheim-NTH, Norway.

Future Conferences

The Fifth FASE Conference will be held in Lisbon in June 1987 and will be hosted by the Acoustical Societies of Spain and Portugal. The proposed topics are: (1) oceanographic acoustics, (2) acoustics in biomedical applications, and (3) harmonization of hearing preservation regulations. There will be a satellite symposium on ocean bottom acoustics. The Fifth FASE Symposium will be held at the University of Thessaloniki, Greece, during the last week of August 1985, with the Hellenic Acoustical Society as host. The proposed topic is architectural acoustics in a broad sense. The Sixth FASE Symposium will be held in Hungary during the first or second week of September 1986. This will be jointly hosted by Hungary, Czechoslovakia, and Austria. The topic will be subjective evaluation of objective acoustical phenomena.

Overview of FASE

FASE, founded in 1972, is an umbrella organization for 26 acoustical groups from 21 European countries. The newest member is the USSR, which was accepted at the August 1984 meeting of the executive council. The other countries represented are: Czechoslovakia, Rumania, Hungary, Denmark, Finland, The Netherlands, Norway, Sweden, Belgium,

of medical acoustics, nondestructive testing, and acoustic emission. Most of the papers emphasized experimental work and survey data rather than theory or computer modeling. Since the meeting operated with three parallel sessions, I heard only a part of the presentations and will comment on only a very few.

Conference Papers

Bjorn Angelsen (Norwegian Institute of Technology, Trondheim) gave an excellent survey paper on the instrumentation for ultrasonic imaging and Doppler measurements for medical applications. The most advanced systems use phased arrays with dynamic focusing, operating in the frequency regime from 1 to 7.5 MHz, with ranges up to about 8 cm for the lower frequencies and higher resolution but less range at the higher frequencies. Two megahertz seems to be optimum for Doppler measurements. Pulse lengths of 1.0 μs are typical for imaging. He described a time-shared system for imaging (22 ms) and pulse-Doppler spectrum measurements (45 ms). One major limitation is designing equipment such that the beam can penetrate between the ribs in the rib cage to reach the region of primary interest. In one arrangement the equipment operates in either of two modes (not simultaneously): short pulse for imaging and depth measurements, and continuous transmission for Doppler measurements. Blood flow rates may be as high as 6 m/s, but generally are much lower and thus more difficult to measure accurately. The author gave a good review of the physical laws relating to acoustic parameter selection (resolution, absorption, and scattering).

Christian Thaulow (SINTEF Division of Materials and Processes, Trondheim, Norway) gave an interesting paper on the relationships between corrosion fatigue cracks and acoustic emission. The primary application of his research is to monitor offshore structures. Acoustic emission is sensed to detect, locate, and classify cracks in the metal structures. Acoustic emission provides a means for continuous monitoring. The equipment used by Thaulow was resonant in the 200-kHz range. Differences in arrival times at four microphones attached to the metal surfaces were used to calculate the location of the cracks. A popular way to display results is to plot number of events (acoustic emissions) as a function of time. A growing crack has lots of emissions. He described a laboratory research program to correlate corrosion fatigue cracks and the resulting emissions. He obtained a high correlation between crack size and acoustic emission rate. The activity increased during the rising part of the load cycle. Excellent crack location was achieved during periods with moderate and high acoustic-emission activity.

Ulrich Kurze (Muller-BBM GmbH, Munich, West Germany) gave an invited paper on noise propagation in open and built-up areas. He described German experience in using man-made barriers and trees to attenuate highway traffic noise. Turbulence is an important factor, but it is difficult to know how to make measurements which are relevant to the traffic-noise problem. Kurze presented considerable field data for moving noise sources in terms of level and horizontal directivity and the use of such data in formulating empirical design techniques. The aim is to develop relatively simple prediction methods. Much of Kurze's paper related to comparing prediction results with on-site measurements. Elevated metro noise is an important problem for which little work has been done.

K.A. Abrahamsen (A.S. Veritec, Hoevik, Norway) discussed noise problems in the offshore oil industry. Offshore oil structures, both drilling and production platforms, are unusual in that a large industrial activity, including offices and the hotel facilities for up to 600 people, is combined into a very compact piece of real estate. Noise problems include: (1) hearing hazards and masking of warning signals in the working modules; (2) speech intelligibility in control rooms, radio rooms, and offices; and (3) noise annoyance in the accommodations. At present, some of the noise levels are above those considered safe, and government regulations are to be issued soon. Drilling rigs are especially noisy, with brake and drum noise being particularly bad. Production rigs are also noisy, but conventional remedies are suitable.

Jan Bennett (Acoustic and Vibration Technology, Stockport, England) discussed noise problems with onshore oil and gas rigs. Most of us are well aware of the UK offshore operations in the North Sea, but are less aware of the magnitude of the onshore activity in England. Much of the drilling is being done in high-population residential areas. A new regulation requires that rigs be at least 300 m from any residence. Noise surveys are made at potential sites and on-site after the equipment is operating. Conventional techniques for noise reduction, such as enclosures for diesel engines and pumps, seem to be adequate. Drilling rigs are much noisier than production facilities for onshore operations. It was stated that motorways with high traffic density (are there any

for other authors. The statistical properties of lidar returns and correlation methods used to measure boundary layer winds were discussed along with results from a DIAL and Raman lidar. While the Soviets appear to be limited by electronics, their lidar research should not be overlooked. The perspective of their research is different from Western research; and, in particular, their research into the statistics of lidar returns may uncover significant results.

Future Lidar Systems and Applications

Proposals discussed in the session on future lidar systems and applications included remotely measuring drought effects to vegetation, oil spills, and atmospheric pressure. The studies of satellite lidar systems were described. A fascinating difference could be noted between the complex NASA/CNES DIAL system proposed by Flamant and Browell, and the relatively simple, single-wavelength lidar proposed by Endemann (Battelle-Institut, West Germany). A talk by Ismail (Systems and Applied Science Co., US) indicated that the NASA/CNES DIAL system flying in the ER-2 airplane could measure ozone and water vapor to an accuracy of 20 percent and 10 percent respectively. Since the lidar signals are inversely proportional to the square of the range, the satellite heights severely limit the strength of lidar signals. Quenzel's (Universität München, West Germany) presentations used a computer study to show these limitations for a lidar operating at 0.7 microns at a height of 800 km. The lidar will be able to observe clouds; but solar background radiation will limit atmospheric aerosol measurements at this wavelength during the daytime. Future lidar conferences will provide a chance to continue these discussions on spaceborne lidars.

Conclusion

The conference speakers emphasized lidar's changing role from an experimental to an operational tool. For example, lidar has in a few years become central to both pollution and stratospheric research. In addition, lidar technology has matured considerably over this period. In an invited paper, Schotland (University of Arizona, US) discussed the history of DIAL development. In the early years the speed of electronics and the lack of mass storage devices greatly limited the measurement possibilities. Now, the primary limit is in the wavelengths at which lidars can operate. However, as Killinger (Lincoln Lab, US) said, excellent progress is being made to extend the lidar wavelengths. During the conference, results were shown of lidar measurements made from ship, airplane, truck, and balloon. Clearly the next platform will be a satellite. Next year's conference should show the continuing progress toward achieving this goal.

12/15/84

Technology

FEDERATION OF ACOUSTICAL SOCIETIES OF EUROPE HOLDS 4TH CONGRESS

by Chester McKinney. Dr. McKinney, formerly at ONR, London, is Senior Research Scientist at Applied Research Laboratories, The University of Texas at Austin.

The Fourth Federation of Acoustical Societies of Europe (FASE) Congress was held at Sanderfjord, Norway, from 21 through 24 August 1984. There were about 190 participants from 26 countries, with 35 percent being from Scandinavian countries and with some representation from most of the other European countries and a few from other continents. (The US had seven attendees.) FASE has over 6000 members, so the attendance may seem low; this is probably is due to two factors. First, travel money seems to be rather scarce in Europe as compared with the US. Probably of more significance is the policy for each FASE congress to cover only a very few topics. In the case of this congress the topics were: (1) planning with respect to community noise, and (2) acoustical methods in condition monitoring and diagnosis. There was little incentive for those who work in other areas to attend. This congress was sponsored by FASE and the Norwegian Acoustical Society, which has about 200 members and was celebrating its 30th anniversary. The president of the organizing committee was Truls Gjestland, and the secretary was Jan Tro.

The technical program consisted of nine invited papers, 94 contributed papers (another 15 were "no-shows"), and 17 poster papers. Most of the papers dealt with transportation and industrial noise and noise control, and with airborne sound. Only 14 were in the areas

radiation limited atmospheric aerosol measurements at this wavelength during the daytime. These results show the limitations imposed on lidars placed on polar-orbiting satellites, which must orbit at 800 km.

Stratospheric and Mesospheric Research

Lidar has dramatically improved our knowledge of the stratospheric and mesospheric dynamics as well. McCormick (NASA Langley Research Center, US) discussed the lidar measurements of stratospheric aerosol from the El Chichon volcano. This aerosol cloud was monitored by six lidars distributed throughout the northern hemisphere. McCormick showed plots of the height and the peak backscatter signal of the cloud over a 17-month period. The data show the gradual global dispersion of the cloud from the tropics to the upper latitudes. In addition, the height of the maximum return decreased from above 25 km to 22 km with particle sedimentation. These data, when coupled with airborne measurements, will allow atmospheric scientists to model the transport of volcanic dust and estimate the radiative effects on the Earth's atmosphere.

Another example of stratospheric and mesospheric measurements was presented by Chanin (CNRS, France). CNRS has been using lidar to regularly measure the Rayleigh scatter between 30 and 100 km. Temperature and density can be inferred from these lidar profiles. Time-height cross sections of density and temperature revealed the presence of density waves. As Chanin pointed out, these measurements are important long-term tools for determining the effect on the stratosphere of man, volcanos, and solar variability.

Between 80- and 120-km altitudes there is a thin layer of calcium; this layer has been monitored by Observatoire de Haute Provence in France for several years. Granier (CNRS, France) showed cross sections of the layer; these cross sections, having 600-m vertical resolution and 6-min temporal resolution, revealed the considerable variability of the layer. Ca and Ca^+ have resonance lines in the ultraviolet that can be monitored from ground-based lidar to determine the density of the calcium species. Comparison of Ca and Ca^+ should be useful for understanding the coupling chemistry between these two species.

Pollution Research

A session was devoted to the measurement of pollutants. DIAL systems can remotely measure concentrations of molecules with appropriate absorption bands. This capability alone has made lidar a major participant in pollution studies. Five papers were presented on the field experiment to measure pollution around the Fos-Berre area of southern France. The area has a complex terrain, including a lake and a Mediterranean gulf. Three oil refineries, a steel mill, and a power plant were within the area studied. Four DIAL systems and two single-wavelength lidars took part in the field experiment. Marzoratti (Ente Nazionale per l'Energia Elettrica [ENEL], Italy) and Capitini (Commissariat à l'Energie Atomique [CEA], France) presented detailed talks on the DIAL measurements of sulfur dioxide. Comparisons of the DIAL systems showed an excellent agreement between the different measurements; for example, between the ENEL and CEA systems, the density difference was less than 40 $\mu g/cm^3$. The systems could routinely measure vertical cross sections of the sulfur dioxide plumes, determining the range altitude of maximum pollution.

Hoff (Atmospheric Environment Service, Canada) showed results from a single-wavelength lidar mounted on a truck. This lidar was pointed vertically, and cross sections were made as the truck drove along the edge of the lake. By combining the DIAL results and those from a sulfur dioxide detector on the truck, Hoff was able to infer the movement of sulfur dioxide over the complex terrain. In particular, he showed the transport of pollution in the morning from the lake, where the pollution collected overnight, to the surrounding land. From a meteorological view, these results provide important information about the movement of pollution and, from a technological view, these results show the usefulness of a simple, single-wavelength lidar.

Russian Lidar Research

A discussion of the conference would not be complete without mentioning Soviet papers. Zeuv (Institute of Atmospheric Optics, USSR) presented an invited talk on Soviet lidar work. While I found his discussion of overall Russian goals vague, he did provide a number of interesting details on Soviet lidar research. For example, he showed the ionization trail of high-energy laser graphically suggesting a close relationship between his lidar research and research into atmospheric propagation of high-energy laser beams. Apparently considerable research is done on laser beam propagation through large aerosol chambers. Zeuv and Mironov (Institute of Atmospheric Optics, USSR) presented their own papers and a number

THE 12TH INTERNATIONAL LASER RADAR CONFERENCE

by William P. Hooper. Mr. Hooper is a researcher in the Atmospheric Physics Branch, Naval Research Laboratory, Washington, DC.

The 12th International Laser Radar Conference was held in Aix-en-Provence, France, from 13 through 17 August 1984. Over 100 papers were presented on laser remote sensing of the atmosphere.

Lidar (light detection and ranging) techniques for measuring scattering from aerosols (dust particles), differential absorption, and Doppler shifting were discussed. These techniques have application to meteorology, atmospheric chemistry, oceanography, and communications. The subjects discussed at the conference were too varied for any comprehensive description; instead, I have selected subjects for detailed discussion. For more information, see G. Megie, *Abstract of Papers, The 12th International Laser Radar Conference* (Aix-en-Provence, France, 13-17 August 1984).

Spaceborne/Airborne Lidars

Many speakers mentioned the need to move from the current airborne lidars to spaceborne lidars. Grassl (Institut für Meereskunde, West Germany) spoke about the need for spaceborne lidars in meteorology. For example, the height of clouds in pictures taken from meteorological satellites must be estimated from passive radiometry. Lidar can directly measure these heights and, as Grassl suggested, dramatically improve estimates of cloud-top height. In the same session, Spinhirne (National Aeronautics and Space Administration [NASA] Goddard Laboratory, US) experimentally confirmed these conclusions when he showed measurements of California coastal stratus and cirrus made by a lidar pointing down from an ER-2 (an advanced U-2) airplane. The lidar measured backscatter at 0.53 and 1.06 microns, and depolarization at 0.53 microns. Simultaneous observations were also made with an 11-micron passive radiometer. The cloud-top heights measured by lidar were distinctly better than those estimated from radiometer data. By measuring the depolarization of the laser beam, Spinhirne could also distinguish between clouds made of ice crystal and water drops.

Browell (NASA Langley Research Center, US), in an unscheduled talk, showed recent observations from an airborne differential absorption lidar (DIAL) system of the troposphere. DIAL systems operate at two spectrally close wavelengths: one on a molecular absorption line and the other outside the absorption line. The backscatter signal from the wavelength outside the absorption line is used to remove the atmospheric effects not caused by the molecular absorption; the remaining signal is, therefore, a measure of the molecular concentration. The NASA DIAL system can (depending on the wavelengths) measure aerosol, water vapor, and ozone. Browell presented three vertical cross sections below different flight paths that showed a tropical maritime boundary layer influenced by an island, a rain forest boundary layer, and a troposphere where ozone was being transported down from the stratosphere. While Spinhirne and Browell showed important measurements, their results also indicate the information potential of spaceborne lidars.

Proposals for two differently designed satellite-based lidars were presented at the conference. Flamant (Centre National de la Recherche Scientifique [CNRS], France) and Browell, in separate papers, discussed the work being done jointly by NASA and France's Centre National d'Études Spatiales (CNES) to develop a DIAL system for remotely measuring water vapor, ozone, aerosols, and clouds. The system is designed to operate from the NASA ER-2 aircraft. The system would use a YAG lasar, doubling crystals, and a dye laser to generate four wavelengths. Since the airplane has severe space limitations, the system would by compact, occupying a little more than 2 m^3. Ismail (Systems and Applied Science Co., US), in a related paper, showed that a DIAL lidar operating from a plane at a 16-km altitude could measure water-vapor profiles to an accuracy of 10 percent and ozone in the stratosphere with 20-percent accuracy. While this system will initially be airborne, Ismail is also evaluating spaceborne limitations, and NASA and CNES are also interested in developing a similar satellite-based lidar.

A simpler satellite lidar was proposed by Endemann (Battelle-Institut, West Germany) in a study done for the European Space Agency. The proposed lidar would transmit in one wavelength and only measure backscatter profiles. His conclusion was that such a lidar could operate at 800 km and provide a resolution of 150-m vertically and 20-km horizontally. Quenzel (Universität München, West Germany) presented computer-simulated lidar observations of clouds and aerosol. The modeled lidar was in an orbit 800-km above the Earth's surface and operated at 0.7 microns. While clouds could be seen, solar background

Washington and met with the Administrator of the National Aeronautics and Space Administration (NASA), James Beggs, and the Reagan administration's Science Advisor and Director of the White House Office of Science and Technology Policy, Dr. George A. Keyworth. In addition to presenting these plans to them, he also proposed to NASA that an Italian astronaut be selected for flight on the space shuttle in 1986.

Italy and her scientists have participated in many areas of space research. The unique San Marco equatorial launch platform in Kenya has supported many launches of the US Scout vehicle. Italian industry has been particularly active in the area of telecommunications. Cooperative international projects have been carried out with the US and ESA. The recognition of these many areas of activity and of the anticipated future commercial returns from such continued investments in high-technology research and development have led to the proposal for the new agency.

In response to invitations to participate in the US space station, Italy and West Germany proposed the COLUMBUS space module as an autonomous development to US efforts. Indeed, the COLUMBUS proposal was reviewed by the ESA Council of Ministers at its January meeting. Italy already has negotiated an agreement with the US to fly a Tethered Satellite System (see *ESN* 39-2:62-64 [1985]) on NASA's space shuttle beginning in 1987.

The main thrust of the Italian space industry is in four areas: structures (large ones erected in space), solid propulsion, systems communications, and remote sensing with synthetic-aperture-radar data processing. There is an intense desire for independence in these developmental areas, as evidenced by the IRIS solid propellant upper stage which, when launched from the space shuttle (or Ariane-3), will be able to inject payloads of up to 600 to 900 kg into a geostationary transfer orbit or other required orbits. It will be complementary to (read "can replace") other similar upper stages developed in the US but will be entirely developed by Italian industry.

The ITALSAT satellite is a medium-sized telecommunication satellite (1250 kg at launch) operating in the 20- to 30-GHz band to study multispot antenna digital telephonic service with data rates above 64k bits per second and carrying an experiment to study the phenomena of propagation in the 40- to 50-GHz band. Italy already has an agreement with the People's Republic of China (PRC) for future joint space research. After moving the earlier-launched (1977) geostationary satellite SIRIO in longitude to place it over the PRC, Italy began in 1983 conducting joint experiments studying the ionosphere and radio propagation under severe meteorological conditions.

In the scientific area, Italian scientists have participated importantly in many of the ESA and US satellite projects in areas of x- and γ-ray astronomy, radio astronomy, space plasma physics, and microgravity investigations. An interesting commentary on the present US administration's attempts to limit the transfer of high technology is borne out by the experiences of the CNR Institute for Cosmic Physics and Related Technologies in Milan. As joint participants with the French in the USSR high-resolution γ-ray astronomy mission, GAMMA-1, three Italian CNR laboratories--including Milan and also Bologna and Frascati--agreed to provide a star sensor unit, including electronics, for reconstruction of attitude data to sub-arc-minute accuracy. Because of the USSR payload involvement, the US forbade the Italians from using an image dissector produced by the US. Rather than drop out of the collaboration, the Italian industry was able to obtain a suitable unit from a Japanese firm, space qualify it and deliver it to the French for incorporation in the experiment. Thus, the net effect of the administration policy has been to deny a US producer a market opportunity and to have stimulated a second source to be competitive with the US. While this policy, no doubt, has some merits for certain products, clearly in this case it has had some interesting secondary reactions.

In fact, the general attitude throughout Europe these days appears to be one of eagerness to undertake more major space technological challenges than previously. The typically conservative approach of the Europeans is being partially abandoned in order to stimulate the local industrial groups and to make space financially lucrative and, hopefully, profitable.

Guerriero is particularly optimistic that if the scientists work closely with the industrial teams to support common programs, then the space station and other projects would go forward. His optimism is in part due to his own experience in "big" physics. A 5-year plan for the period 1982-86 was prepared at the end of 1981 and has formed the basis for the formation of Italy's new space agency.

11/29/84

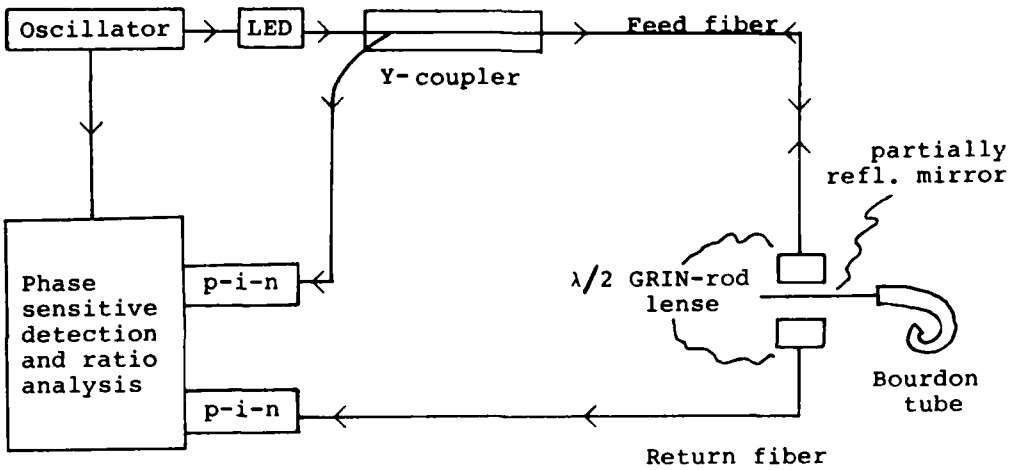

Figure 1. Extrinsic optical-fiber sensor.

mirror is brought back to the terminal equipment, using a return fiber. This enables the measurement to be made independent of the instabilities associated with the optical source and the feed fiber.

The system has been tested and showed outstanding performance. Planned work concerns development of techniques for multiplexing several of the sensors to a single optical fiber link.

The second project addresses a special niche in the area of optical fiber communication. Currently, for long-distance optical communication, infrared systems with a 1.1- to 1.6-μm wavelength are used. Short-haul optical communication (such as within a factory or large naval vessel) has not been adequately addressed by using appropriate methods and realizations to fulfill special needs. This is the need Senior wants to respond to. He uses 0.8-μm radiation and concentrates on special criteria: low noise and a truly remarkable dynamic range (23 dB) receiver. The novelty consists in inserting a logarithmic stage in the amplifier. By two-stage transistor action the signal is then strongly compressed. The entire receiver is realized on a hybridized printed circuit, about 1-square-inch large.

Conclusion

It appears that the scientists in Manchester are engaged in a variety of (somewhat unconnected) areas of opto-electronic and micro-electronic research which are attracting notable industrial interest.

12/5/84

Space Sciences

ITALY PLANS INDEPENDENT SPACE AGENCY

by Norman F. Ness. Dr. Ness is the Liaison Scientist for Space Physics in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on reassignment until June 1985 from Goddard Space Flight Center, NASA, where he is Chief, Laboratory for Extraterrestrial Physics.

Since 1979, the space activities of the Italian scientific and technological community have been supervised by the Piano Spaziale Nazionale of the Consiglio Nazionale delle Richerche (PSN/CNR) under the capable guidance of its director, Professor Luciano Guerriero. But his position is only part time, since he is professor of physics at the University of Bari and commutes to Rome weekly to manage his PSN/CNR responsibilities. In spite of continuing difficulties in the national economy, the Italian government is proceeding with plans to form a cabinet-level space agency to oversee all national space activity and to represent Italy in its international cooperative programs. Italy has been a charter member state of the European Space Agency (ESA) and contributes about as much to financially support ESA as it does to its national programs. It is hoped that the new space agency will be approved and the appropriate law passed in early 1985. As many as 200 persons would be employed in the new agency.

Last fall the Minister of Scientific Research, Luigi Granelli, visited

industry support. Furthermore, the expensive circuit design and production machinery was purchased from university funds because the group uses it also for pioneering instruction of large groups of advanced students.

Jones confidently summarizes his group's activities by saying that "we can really *do* things that other people keep saying ought to be done. Try us!"

UMIST

Professor R.W. Munn of the Department of Chemistry is heading a fast-growing research group in the area of molecular materials research and development, with an eye on molecular electronics and, specifically, opto-electronics applications. The ultimate aim is to devise materials by molecular manipulation of, mainly, organic substances in a manner that will make the products effective in integrated optics devices. The background to this effort is the observation that the conversion of light signals to electric signals (for manipulation) and then converting back is inefficient and that one should try to manipulate the optical phase directly. This goal is hard to achieve with conventional materials, but substitutions on molecules appear to improve or change some crucial properties of substances. By now, Munn and others have developed molecular materials that have very high nonlinear optical indices, comparable to doped $LiNbO_3$, but with better resilience and adaptability. For example, certain nonlinear organic materials are surprisingly resistant to laser damage, probably because the large number of internal degrees of freedom dissipate the impact easily. Also, very high thermal conductivity coefficients, and hence large thermal stability, have been observed with these products.

One of the developing fields of concentration at UMIST is the study of the molecular theory of both linear and nonlinear dielectric response and structure of organic electro-optic and nonlinear optical materials, probably of polymeric nature. This high-intensity effort is funded under the SERC/Department of Trade and Industry Joint Opto-Electronics Research Scheme (JOERS), involving collaboration with such diverse organizations as British Telecom, Imperial Chemical Industries, General Electric Company (UK), Plessey, Oxford University, Strathclyde University, and other establishments. The reasons for such intensive activity are many, such as:

- Anisotropic conducting polymers (three-dimensional structures) surely have more exiting properties than one-dimensional systems.
- Use of polymers, quite generally, eliminates problems of crystal growing.
- Properties of piezoelectric polymers (and other oddly behaving polymers) have not been studied so far.
- Molecular electronics, in conjunction with semiconducting polymers may open completely new avenues of interdisciplinary activity.
- Polymers offer the possibility of very large area (sheet) devices which can not be realized with crystals.

Manchester Polytechnic

Professor J.M. Senior of the Department of Electrical and Electronic Engineering realizes the special environment for research that is predetermined by the nature and mission of polytechnics and endeavors to conduct research which does not place too many demands on manpower and resources. Currently he is conducting two independent projects.

The first project concerns the construction of rugged, cheap, reliable telemetry systems with fiber sensors. It is well known that there are two basic types of such sensors: (1) intrinsic, where the fiber itself is used as a sensing element and interferometry is employed for readout; and (2) extrinsic, where the coupling between an input and output optical fiber is modified by more conventional techniques. Senior believes that for monitoring hazardous environment regions and for achieving commercially attractive low prices, extrinsic systems may have a significant edge over intrinsic ones. As a particular illustration, he and his students just completed the basic construction of a novel extrinsic optical-fiber sensor, suitable for both pressure or temperature monitoring (Figure 1). Incoherent light from an inexpensive light-emitting-diode source is transmitted along a multimode graded index rod lens coupler system (commercially available from NEC). Measurement of displacement (caused by the rigid connection to the bourdon tube of a commercial pressure or temperature gauge) is performed by linear movement of a partially reflecting mirror parallel to the axis of the coupler. The signal is reflected back down the feed fiber and is separated through a Y-coupler for detection with a p-i-n photodiode at the terminal equipment, where phase-sensitive detection is performed, using as a reference the modulating signal to the optical source. Furthermore, an optical reference signal transmitted through the lens coupler and

theory, adapted for the case of smectogenic compounds. In particular, the pretransitional effects occurring in the isotropic phase of the higher order homologs in the alkyl-cyanobiphenyl series have been studied by the optical Kerr effect and by flexo-electricity.

Further work in the classical cholesterol-type systems uses the unusual technique of changing the surface topography of both the metal base and of the glass cover plate in order to achieve a change in alignment. Moreover, by using an electric field to cause misalignment, the researchers have achieved interesting and very stable color changes. (The device consists of a metal electrode base upon which a 20-μ liquid crystal layer is deposited, covered by a thin glass plate and a transparent electrode. The voltage needed for producing the effect is about 50 V.) The mechanism of the phenomenon is not clear. Probably it is the unwinding of the helix, but bending may be also important.

To study such phenomena, a diagnostic tool has been developed. This is based on normal reflection spectroscopy with high-speed optical modification.

Further plans with the cholesterol type of liquid crystals concern the production of nonlinear optical responses (frequency doubling), which has never been done before.

A completely new line of research focuses around side-chain polymer liquid crystals. The particular substances studied so far were cyanobiphenyl-based polymers with side chains (supplied by a cooperative program with the University of Hull). Apparently, the main potential for side-chain polymer liquid crystals is for electro-optic storage devices. Various external circumstances (heating-cooling) and application of differently varying electric fields have been used to produce definite color and texture changes. It has been established that the highly optically polarizable cyanobiphenyl side groups become oriented perpendicularly to the glass surface of the sample in the region of the applied field. Textures achieved at room temperature in the smectic phase (20°C above the glass transition temperature) remained stored for at least 18 months without deterioration in their optical properties. Although the response times of these new polymeric smectic materials are longer than for equivalent monomeric materials, they have several advantages. For example, no aligning agents are required in order to obtain a suitable scattering structure. Clearly, no polaroid is needed as with conventional read/display devices. Also, by writing in the biphasic region and thus cooling back into the smectic phase, optical textures may be readily stored which have a very high contrast between the "on" and "off" states.

At any rate, Coles and his associates believe that these novel liquid-crystal polymer systems will lead to a new generation of optical storage media. Topics and applications to be studied by the Manchester group include:

- Laser writing on these materials (beam heats up and erases previous orientation and re-orients in direction of electric field).
- Applications for optical computing (on the micron scale).
- Q-switching (by putting these materials into the optical cavity of the laser, which will align/counteralign like a mechanical switcher).
- Tunable optical frequency doubling (by electric alignment).

Electrical Engineering Department. Professor P.L. Jones heads a group of nine people doing technical research in integrated optics device development and electron beam lithography. This unit has now a 10-year-old tradition in developing efficient techniques for growing single crystal or other thin optical films of zinc sulphide and zinc selenide on silicon-gallium-arsenide substrates. (This work complements metallo-organic vapor phase epitaxy studies by Professor of Chemistry J.O. Williams at UMIST.) Depositing II and VI materials on different substrates, they obtained precisely working but high-loss, slab-type visible light wave guides. Their current new work, supported by the SERC, eliminates the losses by using a GaAs substrate, covered by a ZnS buffer layer, and followed by a ZnSe top layer. These double-layer devices are produced by epitaxial growth. They also have now low-loss wave guides with three-layer grading. Since these devices have been combined into various visible-light wave guide systems and other optical paths, they may play an important role in optical processing when, as expected, workable II-VI, visible-light, solid-state lasers will become available.

Since fabrication of high-quality optical wave guides demands more precise shape etching than can be achieved with optical beams, Jones' group has a working program to develop advanced techniques in electron beam and molecular beam lithography. Computer control of the beam sources is now being studied. Of course, similar techniques can be used for fabricating quite diverse optical logic circuits. Consequently, in this area the research group has notable

output. VUMAN Lasers also supplies various fiber-optic delivery systems with large aperture coupling, particularly suitable for the delivery of high-energy laser pulses and continous-wave (CW) powers.

Plans for the future include the following:

1. Advanced models of their iodine laser will be converted to flashlamp-pumped dye lasers, primarily to supply the 630-nm and 577-nm lines used in cancer treatment applications, thus replacing CW gas lasers used so far; these tend to be dangerous and expensive. Futhermore, it seems possible to scale up these lasers to extremely high-output, high-repetition-rate models.

2. VUMAN plans to develop a high power, frequency- and amplitude-stable CW iodine laser with 1.315-μm output. They will use their previously developed, unique, close-cycle recirculation of the iodine gas. Such a laser will be particularly useful for feeding special fiber-optics output systems, such as those employed in submarine cable communication links. It is known that Soviet labs (as well as Bell Aerospace Textron in Buffalo, New York, and the US National Aeronautics and Space Administration Langley Research Center) are much interested in such development work.

3. Bannister believes that the advantages of huge (kilowatt) chemical iodine lasers and of the Manchester-developed photochemical lasers could be combined by devising "chemically assisted" iodine lasers. These would still use organic I-compounds as iodine donors to start with, but would inject excited O_2* into the mixture to improve power.

4. Finally, preliminary work is on the way to develop sophisticated fiber-optics systems for UV applications.

UMIST

The Department of Pure and Applied Physics at UMIST headed by Professor J. Latham, as well as Dr.H.M. Smith, is primarily interested in laser applications for atmospheric physics.

Professor P.F. Browne has filed a UK Patent Application (No. 8121156, 1981; published August 1983) for a laser system device to convert laser frequency in a wide range. The special importance of this research is that it may be possible to use shorter wave laser sources for the efficient generation of submillimeter range radiation. The essence of the idea is to construct a system that enables beam expansion in an amplifying medium followed by beam reduction and then by passage through a nonlinear medium. Feedback is ensured by enclosing the system in a single optical cavity. After completing a cycle, the beam may be returned to the first stage either directly, or via a second transit through the nonlinear medium, or via a complete reverse pass through the optical system. It should be possible to use a cavity in which the expansion and reduction sections are identical or in which the amplifying medium and the nonlinear medium are one and the same. There is considerable freedom of choice of the nonlinear process as well. One example is frequency conversion by stimulated Raman scattering. This would lead to conversion of the 10.6-μm radiation from CO_2 lasers into far infrared radiation when the beam passes through gases such as CH_3F. Higher order harmonics generation is another example.

Conclusion

There is a vigorous, multifaceted, often innovative laser research effort at Manchester, and it will be worthwhile to follow developments there in the future.

12/4/84

MANCHESTER, A NEW KIND OF UNIVERSITY TOWN: ELECTRO-OPTICS AND FIBER APPLICATIONS

by Paul Roman.

Research, over quite a span of fields, is done in the electro-optics area at the University of Manchester's Physics Department and Electrical Engineering Department, UMIST's Department of Chemistry, and Manchester Polytechnic's Department of Electrical and Electronic Engineering.

University of Manchester

Dr. H.J. Coles of the Physics Department is engaged in a new and growing line of research activity toward the study of electro-optical effects in different kinds of liquid crystal materials. Practical applications are also pursued. The work is efficiently supported by the UK's Science and Engineering Research Council (SERC), and VUMAN Ltd. (see page 100) is currently contemplating the establishment of a liquid crystal division for commercial use of applied results.

One line of research deals with the isotropic-nematic phase transition

pulse generation in small wavelength excimer lasers, Drs. D.A. Jaroszynsky and King constructed, using only readily available materials, a surprisingly simple pulse slicer for pulse-cutting the output of an ArF laser at 193 nm. They employ a KDP electro-optic modulator driven by a krytron-cable voltage pulse generator. The latter is pulsed up to the full-wave voltage of a Pockels cell. With this device, pulses less than 400-ps duration and with hundreds of microjoule energies were obtained. With faster switches, 10- to 30-ps pulses could be achieved; and if a suitable amplifier stage were added, the pulses would be able to deliver tens of millijoules. Jaroszynsky and King are considering further improvements (Raman and Brillouin pulse compression, active mode locking) for the future, so as to obtain spectacular performance.

Applications of Inelastic Laser Light Scattering. Photon correlation spectroscopy and Brillouin and Raman scattering are powerful methods for studying molecular dynamics and, more generally, for unraveling material properties. Application of specially designed lasers and systems make these techniques feasible and profitable. The University of Manchester physics group engages in a vast area of such applications. The group works in cooperation with the Chemistry and the Medical Biophysics Department, the Rheumatology Unit, Imperial Chemical Industries, Pilkingstons, and even foreign universities, and are supported by the UK's Science and Engineering Research Council, Pilkingstons, and the Agriculture and Food Research Council. It would lead outside the scope of this review to list all research in this area and all the studies pursued, so it suffices to simply note current and planned areas of applications: polymer and biopolymer dynamics, study of glasses and amorphous materials, collagen fibrillogenesis, medical studies (blood flow), fast chemical reactions, and rapid temperature rise experiments.

Apart from the major areas described above, King's group is also involved in ring laser development and use of these instruments for gyroscopic purposes. However, because of technical problems, details of this work are not available now. The Royal Air Force (Farnborough), Ferranti, and Marconi support this research area.

VUMAN Lasers Ltd.

The preceding article discusses in general terms the relation of the University of Manchester and the not-for-profit company VUMAN Ltd. Here we specifically review the work of VUMAN Lasers Ltd.

This combined research and development laboratory and high-technology manufacturing workshop is presently located in the Chemistry Building of the University of Manchester, but is scheduled to move soon to a new complex, the Science Park area. Their manufacturing activities are done in-house, with off-the-shelf components bought commercially. Some production (like fiber optic systems) is done by subcontracting; the planned microcomputer control of currently sold lasers will need outside contract arrangements too.

The laboratory is led by Dr. J.J. Bannister, a former student and associate of King. He explained to me how work in the Physics Department on self-induced transparency (soliton waves) and dynamic resonant self-focusing led to the need to develop large high-technology photochemical iodine lasers, electro-optic pulse cutting, and other technological features that could not be accommodated in the Physics Department. This need gave rise to a separate development center and later, when injection locking and flashlight pump systems were constructed, commercial possibilities became evident. This is how VUMAN Lasers came into existence. Current top products are various iodine laser models, (with complete control packs and power packs) and accessories like various flashlamps, an electro-optic Q-switcher, mode-matching alignment and target indicator systems, and an ingenious system for conversion into a dye laser with pulsed, flashlight-pumped tunable

Table 1

Laser Performance

Laser	Emission Range (nm)	Max. Output (mJ)	Max. Efficiency	"Color"
Hg I	441-446	2.9	0.10	blue
Hg Br	495-507	7.5	0.32	blue-green
Hg Cl	535-566	7.8	0.22	red
Hg F	∿ 650	?	?	edge of visible

between structures and the ambient flow medium. Such activities consider both the aeroelastic behavior of aircraft and the effects of the wind on high buildings and bridges as well as hydrodynamic conditions on ship propellers. Increasing research emphasis is being given to aircraft structural analysis for "high g" maneuvering flight because of recent technological thrusts in fighter aircraft aerodynamics and automatic flight control systems allowing high-speed flight and maneuverability beyond the aircraft stall limit. In the area of space technology, questions of human work procedures and experimental techniques in space with special materials and structures are considered in the environment of reduced gravity.

The Research Department for Communications Technology and Remote Sensing has its headquarters in Oberpfaffenhofen. The department's research efforts are concentrated on acquiring information on terrestrial and atmospheric conditions, identifying moving objects with electro-optics/infrared and microwave remote sensing methods, and developing numerical models of meteorological and physical atmospheric processes within the field of remote sensing. Communications technology research is focused on coding and transmitting of information with high data rates over extreme distances and under undisturbed conditions, on arrangement and processing of data flows, and on information display image processing. The department also emphasizes systems analysis and project support for special communications and remote sensing systems.

The Research Department for Energetics has its headquarters in Stuttgart. The main research effort is focused on non-nuclear energy systems, with specific activity in use of solar energy, hydrogen technology, combustion processes, high-energy lasers, thermionic energy conversion, lubrication systems, missile propulsion, chemical rocket propulsion and electric thruster devices.

Research at the Institute of Flight Systems Dynamics

The Institute of Flight Systems Dynamics at Oberpfaffenhofen is headed by Dr.-Ing. J. Ackermann and is one of four institutes within the Research Department for Flight Mechanics/Guidance and Control. In general the institute develops methods and computer systems for analyzing and synthesizing dynamic systems--in particular, those for guidance and control. The main fields of application for such research include guidance and control of guided missiles and aircraft, and the dynamics of wheel/rail vehicles and industrial robotics. The primary research activities are grouped in four areas: guidance, control, multi-body dynamics, and automation.

Dr. Klaus Well heads the Guidance Section, which has been working on the application of mathematical optimization techniques to realistic aircraft and missile flight trajectories and engagement problems involving use of maneuver and guidance laws. The trajectory optimization efforts have concentrated on modeling and analyzing aircraft flight trajectories in the post-stall region and determining maneuvers which maximize engagement opportunities. Additionally, minimization techniques have been used to reduce the radar target cross section of the trajectory of the fighter aircraft as a defensive target. For analytical prediction and solution of the one-on-one fighter engagement problem, differential game, optimal decision-making algorithms have been developed to model aircraft interaction and engagement. The research has resulted in dynamic modeling, analysis, and display of maneuver trajectories that will maximize the probability that fighter aircraft will successfully engage and kill a target. Figure 2 shows a three-dimensional time-history plot of a one-on-one aircraft optimal trajectory engagement involving post-stall maneuverability (or supermaneuverability).

Several maneuvers, for aircraft both with and without post-stall capability, have been investigated to determine the advantages of the post-stall capability for future fighter aircraft. The researchers analyzed minimal-time maneuvers for a variety of flight path constraints and boundary conditions using point-mass models of the aircraft. The results show that under some conditions, flight time can be reduced if high angles of attack are used along with a post-stall maneuver. These capabilities have also been tested and evaluated in the Flight Simulation Lab at Messerschmitt-Bölkow-Blohm in Ottobrunn.

Well and his colleagues have invested considerable effort in developing numerically stable and efficient algorithms which can solve these nonacademic optimization problems and display the optimal maneuvers in a dynamic fashion using computer graphics. Theoretically, this work depends on the use Pontryagin's Maximum Principle incorporating state constraints. Well, along with Professor R. Bulirsch of the Technical University of Munich, said that they have recently developed a new scheme for solving the two-point boundary-value

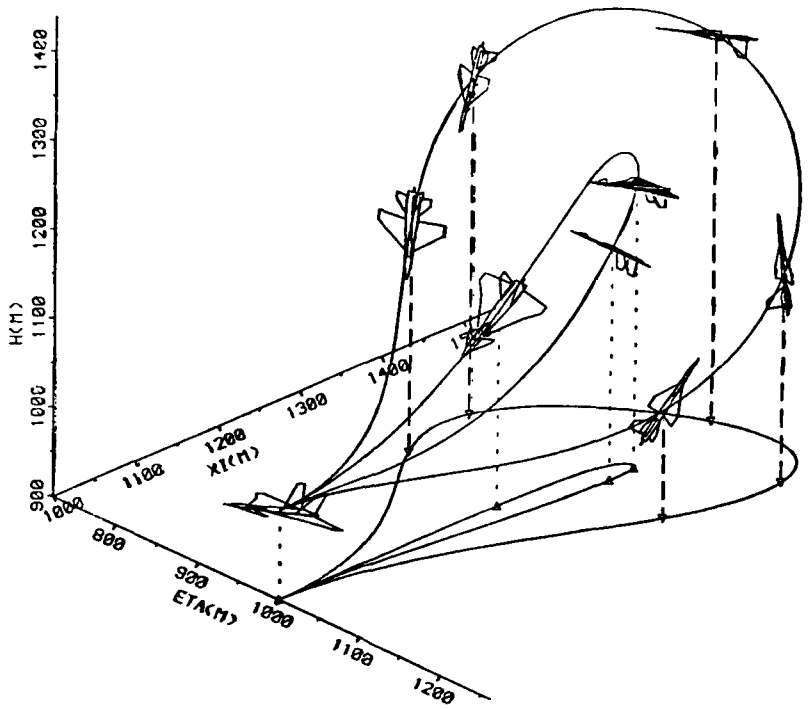

Figure 2. Three-dimensional time-history plot.

problems arising from the Maximum Principle. This approach does not require explicitly treating the equations for the adjoint variables. This would be very helpful for solving many problems having multiple scenarios in which the aircraft characteristics change. Weil and Bulirsch expect to have documentation on this new development soon.

Well has also been working toward the efficient numerical solution of many pursuit-evasion problems arising in air combat. His long-range goal is to develop software to solve the modeled differential games both off-line and in real time. These problems are complicated by the fact that, in addition to dynamics, each of the two aircraft has a choice of being aggressive, neutral, or evasive. According to his analysis, this would require solving 18 pursuit-evasion problems.

The physical system to be controlled in many industrial and military applications is subject to rapidly changing dynamics. For example, highly maneuverable aircraft and missiles encounter rapid changes in aerodynamic characteristics because of variability in the effectiveness of the aerodynamic surfaces. Similar situations occur for high-speed submarines and torpedoes. Designing a stable, fixed-control system over the range of changing dynamics can be extremely difficult. The designer's goal would be an adaptive control design, which implies a self-adjusting system that can achieve acceptable performance in the presence of changing dynamics. Dr. Gerhard Kreisselmeier has been working on adaptive control algorithms for the past several years at DFVLR. Recently Kreisselmeier has constructed a globally stable, indirect, adaptive control algorithm for a class of deterministic linear time-invariant plants (Kreisselmeier, 1985). His procedure is termed "indirect" in that the unknown parameters in the plant are first identified, and then the resulting parameter estimates are used to adjust the controller parameters. By contrast, in a direct approach, the controller parameters are adjusted directly without first identifying the plant parameters.

All known globally stable adaptive control schemes require some prior knowledge of the plant parameters. For example, in the model reference adaptive control scheme which is a direct approach, the plant is restricted to be minimum phase. Kreisselmeier does not make that restriction. Instead he assumes that the plant is of known order, that the unknown parameters lie

in a given convex set, and that throughout this set there is no unstable pole-zero cancellation.

He describes a system as "stable" if bounded inputs produce bounded outputs. The proof of his result depends upon a special nonminimal representation of the plant. In this representation the closed loop system is rewritten as an exponentially stable system with the identification error appearing as a feedback term. This procedure established a link between the identification error and closed-loop-system stability. Then global stability is established in a similar fashion, as in the model reference, adaptive control approach.

This is an interesting theoretical result. Nevertheless, all realistic systems are not linear time-invariant, and adaptive control schemes must be robust with respect to unmodeled dynamics and noise disturbance. There are still many interesting and difficult challenges for Kreisselmeier and others to confront before a totally satisfactory design methodology for adaptive control synthesis is developed.

Reference

Kreisselmeier, G.,"An Approach to Stable Indirect Adaptive Control," *Automatica*, in press.

12/6/84

News and Notes

ESN GETS NEW NAME, NEW LOOK

With this issue ONR, London, introduces a new name and new look for *ESN*.

The name is now *European Science Notes*, not *European Scientific Notes*--to emphasize that we publish science information, news, and analysis, not scientific research papers.

Our new look includes an updated cover design that features a list of the fields treated in each issue. Times Roman is the typeface now used for the cover and for the heads in the text; this typeface has a clean, contemporary look and is easy to read.

Larry E. Shaffer
1/9/85

CORRECTION

There is an error in two of the equations in the article "West Germany Publishes EMF Exposure Standard," *ESN* 38-10 (1984). On page 532, the equation for the electric field strength for exposures greater than 6 minutes (3 GHz to 12 GHz) should read:

$$E = 100\ (f/3000)^{1/2}\ V/M$$

and for the magnetic field:

$$H = 0.25\ (f/3000)^{1/2}\ V/M.$$

Thomas C. Rozzell
12/6/84

URSI HOLDS 21ST GENERAL ASSEMBLY

The 21st General Assembly of the International Union of Radio Science (URSI) was held in Florence, Italy, from 28 August through 5 September 1984. URSI is a loosely knit organization of nine commissions dealing with subjects such as electromagnetic metrology, signals and systems, electronic and optical devices, remote sensing, space plasma physics, and radio astronomy.

In the area of space plasma physics, the meeting was generally devoted to both naturally occurring and artificially stimulated phenomena occurring in the Earth's ionosphere and magnetosphere, although some sessions dealt with magnetospheres of other planets in the solar system.

Naturally Occurring Phenomena

The scientific sessions devoted to naturally occurring phenomena in the ionosphere were divided into low (equatorial) and high latitudes. For the equatorial case, D. Farley (Cornell University, US) presented an overview of the progress in theories and observations of small-scale density fluctuations and irregularities in the E-region equatorial electrojet. Reasonable agreement between existing theories and observations can now be achieved.

G. Haerendel (Max Planck Institute, Garching, West Germany) reviewed theories of equatorial spread-F, with emphasis on a first-principles approach. Haerendel suggested than an outstanding problem in equatorial spread-F is the seeding mechanism causing spread-F onset. At high latitudes, B. Fejer (Cornell University, US) compared observations and theories of small-scale

plasma waves and irregularities in the auroral E-region ionosphere. Fejer suggested that some of the theoretical predictions made for equatorial electrojet phenomena do not agree with auroral electrojet data.

M. Keskinen (Naval Research Laboratory, US) reviewed theories of both small- and large-scale plasma waves and turbulence in the high-latitude ionosphere. C. Rino (SRI International, US) discussed the role of satellite beacon experiments in understanding high-latitude ionospheric structure. Rino showed first beacon results from the Hilat satellite. T. Jorgensen (Danish Meteorological Institute) and V. Wickwar (SRI International, US) gave an overview of first results from the Sondrestrom, Greenland, incoherent scatter radar (formerly located at Chatanika, Alaska). They showed that data indicated in the dayside high-latitude ionosphere the greatest increase in the electron temperature and energy input occurred in or near convection reversal.

Magnetospheric Plasma Phenomena

W. Kurth (University of Iowa, US) showed the striking similarity among electrostatic plasma waves in the magnetosphere of Earth, Jupiter, and Saturn. D. Gurnett (University of Iowa, US) reviewed observations of electromagnetic plasma waves and radiation from the Earth and other planets using various spacecraft data. H. Oya (Tohoku University, Japan) surveyed observations and theories of coherent radiations, e.g., auroral kilometric radiation, in the Earth's space plasma. Emphasis was placed on direct mechanisms for radiation generation, e.g., cyclotron maser instability, as opposed to indirect mechanisms.

Computer Modeling

Two sessions at the conference were devoted to the increasingly popular computer modeling of space plasma phenomena. R. Gendrin (Centre National d'Études des Telecommunications, France) discussed computer simulations of ion cyclotron waves in multi-species plasmas with application to the Earth's magnetosphere. The dependence of the simulations in the nonlinear regime on initial conditions was stressed. T. Chang (Massachusetts Institute of Technology, US) presented computer modeling of ion acceleration by lower hybrid waves in the high-latitude ionosphere. S. Ossakow (Naval Research Laboratory, US) gave a general survey of progress in computer modeling of ionospheric waves and turbulence. P. Palmadesso (Naval Research Laboratory, US) discussed recent computer simulation of particle acceleration by electrostatic waves in the high-latitude, near-Earth space plasma.

Experimentation in Space Plasmas

Finally, several sessions were devoted to active experimentation in space plasmas. These active experiments include ionospheric heating; *in-situ* charged particle beam injections; ground-launched, very-low-frequency wave injections into space; and chemical releases into the ionosphere. Basu et al. (Emmanuel College, US) presented simultaneous measurements of radio-star scintillations and plasma line intensity fluctuations during ionospheric heating at the Arecibo Observatory. Experimental data were compared with self-focusing instability.

Ganguly et al. (Rice University, US) showed the first experimental observations of nonlinear ionospheric mixing of two ground-launched waves. P. Stubbe (Max Planck Institute, Katlenburg-Lindau, West Germany) and J. Fejer (Arecibo Observatory) gave review talks dealing with ionospheric heating experiments conducted at Tromsö (Norway) and Arecibo, respectively.

W. Taylor et al. (TRW Inc., US) presented first results from SEPAC (Space Experiments with Particle Accelerators), which was carried into space aboard the US space shuttle. For currents greater than approximately 50 mA, these authors suggested that beam-plasma discharge occurred with attendant energetic electrons.

R. Treumann et al. (Max Planck Institute, Garching, West Germany) described the space time structure and dynamics of quasineutral ion beams injected *in situ* perpendicular to the geomagnetic field. They showed that the finite extent of the beam to be important and detected both high- and low-frequency plasma waves. S. Zalesak (Naval Research Laboratory, US) presented state-of-the-art computer simulations of the dynamics and structure of ionospheric barium cloud releases.

M.J. Keskinen
12/17/84

NEW ARTIFICIAL INTELLIGENCE GROUP AT UMIST

A new artificial intelligence (AI) group is being formed within the Computing Department of the University of Manchester Institute of Science and Technology (UK). It is necessary to pinpoint, at early stages of their

development, new and potentially significant centers of AI--not because of the rapidly growing popularity of the field but because of its complexity (often ignored by enthusiasts). After all, if real progress is to be achieved in reasonably foreseeable time, all hands will be needed.

Drs. P. Conway and P. Loucopoulos said that the immediate goals of the group are to establish a "developing workbench" approach, and to broaden the scope and efficiency of currently known techniques and approaches, rather than to aim at an immediate thrust into some new area. They are cooperating with International Computers Limited and are eager to apply for Alvey and ESPRIT monies. (For background on the Alvey and ESPRIT programs, see ONR, London, report R-11-84 and *ESN* 38-5:248-252 [1984].)

Most of their current activities can be described as analysis and design of information systems. They believe that too much guess work goes into the building of commonly used systems and that these systems often lack flexibility and easy maintainability because of the lack of front-end analysis before development.

One of the topic areas presently considered is the use of knowledge-based systems as a mechanism for optimization of conceptual design in various projects, ranging from civil engineering to business management. Action-oriented suggestions for future research in optimization of design by use of knowledge processors are discussed intensely.

Another line of study addresses man-machine interface problems. Dr. Sutcliffe works on representing options not by menus but by graph patterns. A well-known psychologist, Dr. Kulikowski, is advisor on this project. In the same area, Dr. Ritchins is concerned with pattern recognition in connection with man-machine interfaces. Ritchins suggests that to extract information from clatter, a procedure of human optical perception inference, based on human nervous system action, should be developed. In these experiments he uses encephalographic and galvanic responses rather than psychological analysis and theory.

It may be indicative of the growing area of the group's interests that Professor Sager from Manchester University's Center for Computation and Linguistics, an expert in language translation, will shortly join the UMIST group on AI.

For more information about scientific research in Manchester, see the series of articles beginning on page 99 of this issue. *ESN* 36-12:323-325 (1982) and ONR, London, report R-10-84 discuss computer science at the University of Manchester.

P. Roman
12/5/84

EEC TO ESTABLISH TELECOMMUNICATIONS POLICY

The member states of the European Economic Community have agreed to work together to strengthen Europe's telecommunications market. According to Christopher Wilkinson--who is responsible for the strategy of information technology and telecommunications in the Task Force for Information and Telecommunications Technologies--the plan is to have a community-wide communications policy.

In a recent interview with me, Wilkinson said that the important elements of this policy are: (1) to agree on communication standards throughout Europe, (2) to initiate cooperative research and development in telecommunications technology, and (3) to establish European Community-wide communications systems via satellite.

On October 15 in Luxembourg the industry ministers of the Community governments adopted two recommendations toward a telecommunications strategy. All 10 governments are to ensure that national telecommunication administrations consult before introducing new services. Contacts now exist between the governments through the European Conference of Post and Telecommunications Administrations, which was established in 1959. Under the new recommendation, new services put into operation from 1985 would have to conform to standards now being laid down by the developing network of European standards bodies. The Community has granted 6 million European Currency Units (about $4.3 million) to these bodies for a 2-year program (1984-85) to define and certify European norms in telecommunications. Equipment other than terminals, such as digital transmission and switching systems, would have to conform to common standards from 1986 onward.

The second recommendation would open bidding to all member states for procurement of conventional terminals (telephone apparatus) and telematic terminals. The recommendation is that at least 10 percent of the annual value of orders for switching and transmission equipment, and pieces of conventional terminal equipment for which there are

no common specifications, should be opened for tender throughout the community.

The Community, with a trade surplus of $2 billion per year in telex and telephone equipment, is trying to develop a second- and third-generation market in telecommunications which can rival that of Japan and the US.

Wilkinson's Task Force for Information and Telecommunications Technologies is responsible for: providing liaison with the electronics industries, including software and consumer electronics; managing the ESPRIT research program in information technology; developing an outline for new telecommunications policy; carrying out economic and industrial assessments; and promoting technical standards.

J.F. Blackburn
12/3/84

4TH INTERNATIONAL WORKSHOP ON ACHIEVING SAFE, REAL-TIME COMPUTER SYSTEMS

This meeting, titled SAFECOMP '85, will take place in Villa Olmo-Como, Italy, from 1 through 3 October 1985 under the auspices of the International Federation of Automatic Control. Presentation and discussion sessions will focus on the safe operation of computer systems, both software and hardware. Topics include: system integrity throughout the life cycle; system-reliability-specification design and assessment; software quality assurance, fault avoidance, verification, and validation; human factors; standards and documentation; social implications of computers in hazardous situations. The working language will be English. For more information, write to: ENEA Dir. REL/ MEDIA, Attention: Ms. Maria F. Tani, 125 V. le R. Margherita, 00198 Roma, Italy.

Richard F. Snow
11/23/84

21st INTERNATIONAL CONGRESS OF APPLIED PSYCHOLOGY

The International Association of Applied Psychology (IAAP) meets in congress every 4 years. The next congress, the 21st, will be held in Jerusalem, Israel, from 13 through 18 July 1986 at the Jerusalem Convention Center and Jerusalem Hilton Hotel. Official languages of the congress are English and French. The main topics will be organized around the themes of the divisions of IAAP: Industrial and Organizational Psychology; Psychological Assessment; Psychology and National Development; Environmental Psychology; Educational, Instructional, and School Psychology; Clinical and Community Psychology; and Applied Gerontology. Other areas to be represented include: health psychology, law and psychology; social psychology and group processes; stress; rehabilitation; sports; economic psychology; military psychology; and applied cognition. For further information and registration forms, contact the Secretariat, 21st International Congress of Applied Psychology, P.O.B. 50006, Tel Aviv 61500, Israel.

Richard E. Snow
11/29/84

NEW BIOTECHNOLOGY JOURNAL

A major new international review journal, *Biotechnology Advances: Research Reviews and Patent Abstracts*, is being published by Pergamon Press. To subscribe, write to: Pergamon Press, Fairview Park, Elmsford, NY, 10523.

The journal will address issues related to future demands for fuels, food, chemical feedstocks, health care, and environmental pollution control. *Biotechnology Advances* has been conceived as a means of keeping researchers and practitioners in academic institutions up to date with this rapidly developing field. The journal will, therefore, be devoted to all aspects of biotechnology, including applied biology, technical biochemistry, genetic engineering, biochemical engineering, and environmental engineering. Its purpose is to provide regular, quick, but authoritative updates on the research literature. Each annual volume, consisting of two issues, will contain mini-reviews plus a detailed bibliography and the abstracts of all relevant US patents. Occasionally, special supplementary issues of the journal will be published as proceedings of conferences or symposia which have addressed state-of-the-art reviews of biotechnology topics.

The value of this journal to the biotechnology community will be enhanced by the inclusion of the section devoted to US patents.

The executive editor is M. Moo-Young, Department of Chemical Engineering, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1. Editors are: J.D. Bulock, Department of Chemistry, University of Manchester M139PL, UK; C.L. Cooney, Department of Nutrition and Food Sciences, Massachusetts Institute of Technology, Cambridge, MA 02139; and B.R. Glick, Department of Biology, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1. The editorial advisory board is international in scope. The members are: D.E. Brown, UK; A.L. Demain, D. Gelford, and E.L. Gaden, US; G. Goma and E.J. DaSilva, France; H.G. Schlegel, West Germany; and H. Taguchi, Japan.

Claire E. Zomzely-Neurath
12/10/84

ONRL COSPONSORED CONFERENCES

ONR, London, can nominate two registration-free participants in the conferences it supports. Readers who are interested in attending a conference should write to the Scientific Director, ONRL, Box 39, FPO New York 09510.

Third International Conference of Low Temperature Biological Microscopy and Analysis, Cambridge, UK, 1-4 April 1985.

The Role of DNA in Brain Activity, Naples, Italy, 27-29 May 1985.

Technological Application of Bilayers, Vesicles, and Langmuir-Blodgett Films, Denerja, Spain, 25-29 November 1985.

EUROPEAN VISITORS TO THE US SPONSORED BY ONR, LONDON

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SCIENCE NEWSBRIEFS FOR DECEMBER

The following issues of *Science Newsbrief* were published by the ONR, London, Scientific Liaison Division during December. *Science Newsbrief* provides concise accounts of scientific developments or science policy in Europe and the Middle East. Please request copies, by number, from ONR, London.

Science Newsbrief Number	Title
2-17-84	Danish Institutes Study Seas, Ports, Ships, by James W. Daniel.
2-18-84	New Transonic Wind Tunnel To Support European Aerospace Research, by CDR L. Laddie Coburn, USN.
2-19-84	New Cathode Material for Long-Life Lithium Rechargeable Cell, by David L. Venezky.
2-20-84	UK To Host Conference on Probe Techniques for Studying Biological Membranes and Other Liquid Crystals, by David L. Venezky.
2-21-84	All-Optical Computer To Be Built in Edinburgh, by J.F. Blackburn.
2-22-84	Simple Approach to Low-Temperature Photochemistry and Kinetics, by David L. Venezky.

DECEMBER MAS BULLETINS

The following *Military Applications Summary (MAS) Bulletins* were published by the ONR, London, Military Applications Division during December. The *MAS Bulletin* is an account of naval developments in European research, development, test, and evaluation. Its distribution is limited to offices with the US Department of Defense. DoD organizations should request copies of the *Bulletins*, by number, from ONR, London.

MASB Number	Title
85-84	New Developments in European C^3I Systems Approach and Design
86-84	Spanish Institute of Oceanography
87-84	Spanish Naval Hydrographic Institute
88-84	New Development for a Next Generation Stores Management System
89-84	Future Fighter Aircraft Maneuverability for Air Combat
90-84	Evaluation of Submarine Escape Immersion Suit--Mk8
91-84	UK Company Markets Undersea TV Cameras and Photo Analysis Service
92-84	Atmospheric Measuring System From UK Company
93-84	Oceanic SAR and HF Radar Research at Marconi Space and Defence Systems (MSDS)
94-84	ELMA--Swedish ASW Grenada Launcher
95-84	External Propulsion System for Submarines
96-84	Fourth Quarterly Index 1984

ONRL REPORTS

To request reports, check the boxes on the self-addressed mailer and return it to ONR, London.

C-8-84 *Fourth International Conference on Robot Vision and Sensory Controls*, by J.F. Blackburn. The Fourth International Conference on Robot Vision and Sensory Controls was held in London from 9 through 11 October 1984. The conference covered the following areas: sensor-based manufacturing, vision systems, sensor-guided welding, three-dimensional sensing, robot guidance and sensory control, nonvision sensing, knowledge-based sensory systems, and advanced vision techniques.

C-9-84 *The 20th International Symposium on Applied Military Psychology*, by Richard E. Snow. The symposium contained presentations on selection research with individual and group instruments, classification and job analysis, personnel systems and organization of psychological services, adjustment to military life and stress, organizational diagnosis and intervention, evaluation of new programs, and new emphases in large-scale research programs for the future.

R-12-84 *French Plans for Fifth Generation Computer Systems*, by J.F. Blackburn. Since the October 1981 announcement of Japan's Fifth Generation Project, the French scientific and industrial communities have shown an increased interest in artificial intelligence languages, expert systems, man-computer interaction, novel computer structures, and knowledge-based computer systems. This report describes the French effort and includes a survey of the various French initiatives in hardware and software technologies aimed toward fifth generation computer systems and applications. These separate projects are the National Projects, the Joint Research Projects, the Centre National de Recherche Scientifique Cooperative Research Groups, and the Thematic Research Program.

R-13-84 *The EEC's Information Technology Program--An Update*, by J.F. Blackburn. The primary goal of the European Stragegic Program for Research and Development in Information Technology (ESPRIT) is to make the countries of the European Economic Community competitive in the world market for information technology. This report examines the five areas of the ESPRIT program for 1985: advanced microelectronics, software technology, advanced information processing, office systems, and computer-integrated manufacturing.

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